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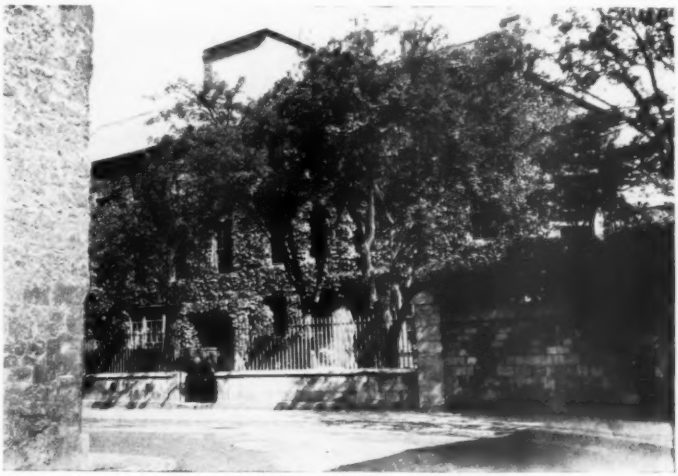
HERBERT HALL TURNER

By ANNIE J. CANNON.

"Shall I call you Doctor or Professor," said an American visitor one day a year or so ago to the Savilian Professor of Astronomy in the University of Oxford. The reply was, "I am proud of my chair. It was once occupied by Halley."

Not only in words did Professor Turner honor his famous predecessor. He has kept green the memory of Halley in Oxford by inducing New College to restore and open to the public the Halley Observatory.



HALLEY OBSERVATORY.

Ah! the thrill of being personally conducted by Professor Turner through this old house, up the narrow, winding stairs to the attic Observatory he has fitted up as a memorial to the great man who two hundred years ago was Savilian Professor at Oxford!

Herbert Hall Turner held the Savilian chair of Astronomy for thirty-seven years, from December, 1893, to August, 1930, when his life was suddenly cut off by a severe cerebral hemorrhage while he was presiding at the International Geophysical Union in Stockholm.

Born in Leeds in 1861, he was Second Wrangler when he graduated

at Trinity College, Cambridge, in 1882, and the next year he was Smith's Prizeman and Fellow of Trinity. In 1884, he was called by Sir William Christie, then Astronomer Royal, to be Chief Assistant at Greenwich. After nine years there, he was appointed Savilian Professor of Astronomy and Director of the University Observatory at Oxford. The training at the Royal Observatory had given him excellent preparation for the Oxford duties inasmuch as both observatories were pledged to prepare a portion of the Astrographic Chart, then a novel and absorbing topic in astronomical circles. This "Carte du Ciel," designed to photograph the entire sky, was the first international undertaking of the new astronomy. The opening convention in Paris in 1887 was attended not only by representatives from fourteen European nations, but also from the Argentine, Brazil, Cape of Good Hope, and the United States. It was thus a forerunner of the International Astronomical Union, in which Professor Turner was deeply interested as a means of bringing astronomers of many nations together in friendly and stimulating relations.

The photography of the heavens is such a universal achievement nowadays that we can scarcely realize the doubts, the perplexities, and the difficulties of the undertaking in the eighteen eighties. Professor Turner's fertile and ingenious mind had early suggested means of overcoming some of these difficulties and of lightening the enormous labor involved in the making of this "Great Star Map," as he himself called it. There was no precedent as to methods for determining positions or magnitudes of stars on photographic plates, so that Turner was literally "breaking fresh ground" when he urged that the positions should be given in rectilinear co-ordinates instead of right ascensions and declinations, and that the measures of the positions should be read off by a scale in a fixed eyepiece, instead of by the slow method of a micrometer screw. His paper in the November, 1893, *Monthly Notices* was the earliest presentation of formulae for reduction of the measures, and for the plate constants. He urged that there be no waste of time and money in efforts to obtain unnecessary precision, for said he, "Moderation and self-denial are just as necessary in astronomical work as in other walks of life."

After giving in February, 1894, his inaugural lecture in the Sheldonian at Oxford, on "The International Chart of the Heavens," he commenced active work on the Oxford Zone, $+25°$ to $+31°$. When finished nearly twenty years later, this portion of the Catalogue contained 400,000 stars, whose positions and magnitudes had been measured on 1180 photographic plates taken with the 13-inch Oxford Astrographic Telescope. One of the by-products of the Oxford zone was the discovery of a new star, known as Nova Geminorum No. 1. It was the brightest star in a field to be photographed on March 16, 1903, and was accordingly used by Mr. Bellamy to set the telescope. The plate which was excellent, had nevertheless to be rejected because for some reason or other it did not cover the desired region. A few days later, Professor

Turner while examining the plate, found an astonishing reason for the misfit. For, said he, "Who would ever have dreamed that a Nova would actually offer itself as a guiding star in a telescope?"

Professor Turner's close association with the Royal Astronomical Society began with his election to Fellowship in January, 1885, and was continued by his services as Secretary from 1892 to 1899, as President from 1903 to 1905, and as Foreign Secretary from 1919 to 1930. Through this secretaryship, there came to him one of his major astronomical interests, when in 1899 he was asked to prepare for publication the long series of variable star observations made by George Knott. This he undertook, and published the results in the *Memoirs of the Royal Astronomical Society*, Vol. 52. One good turn deserves another, so it was that the much heavier task of publishing Sir Cuthbert Peek's observations fell to him (See *M.R.A.S.*, **55**) and later, with Miss Blagg, he edited and published Baxendell's observations. The experience thus gained from a study of these variable stars impressed upon him the importance of observers publishing their own observations. In a letter referring to a meeting of the American Association of Variable Star Observers of which he was an honorary member, he said, "What a splendid company to get together! The output of work must be considerable. I hope you will tell them sometime the story of E. F. Sawyer who made such good observations of W Cygni and then forgot he had made them until I reminded him!" Turner suggested that if observations were not published they should at least be deposited at some observatory where others could obtain them.

His alert mind was now awakened to the problems of the variable stars. How aptly he could bring home the most salient point about a variable! Thus, when one was announced with a period of five and one-half hours, he said that "observations of such stars obviated the tedium of waiting for something to happen, for something was going on all the time." When Bailey showed that in Cluster Variables there is a remarkable tendency for the period to be one-half of a day, Turner notes, "The idea of a time unit common to remote portions of space is almost bewildering."

But I am anticipating the delightful pages of "From an Oxford Note Book." Commencing anonymously in the November, 1894, issue of *The Observatory*, these notes, characterized by humor, geniality, and a thoroughly human touch, never failed to appear for thirty-six years. When in September, 1930, the title read "Last Notes from an Oxford Note Book," I am sure that many in the astronomical world felt that something vital had gone out of life.

A true Englishman in love of his country, in pride of its Newton, its Halley, its Bradley, and its Herschel, he was also English in his love of travel. All his many long journeys were on science bent—eclipse expeditions, international gatherings, or meetings of the British Association in such distant places as Australia.

In 1886, as Chief Assistant of the Royal Observatory, he went to the

West Indies on his first eclipse expedition and between that and the English total eclipse in 1927, he followed the trail of the Moon's shadow to Russia in 1887, to Japan in 1896, to India in 1898, to Algiers in 1900, and to Egypt in 1905. At the Indian eclipse, he introduced the coelostat, and also secured two photographs in polarized light showing polarization of the corona. At the English eclipse in 1927, he was located at Southport, where clouds interfered with scientific results. He rejoiced, however, that the corona was visible and that there was enough of a spectacle so that the quarter of a million people who had flocked there were not disappointed. He himself by lectures, radio talks, and letters to newspapers, had doubtless been the great factor in bringing the crowd to Southport.

Perhaps no other European astronomer has ever been so well known in the United States as Professor Turner. He crossed the North Atlantic first in 1892, going to Montreal in connection with the longitude campaign of the Royal Observatory. Embracing this opportunity to come to the United States, he visited the Washington, Princeton, and Harvard Observatories. He often spoke feelingly of that early visit to Cambridge, and of the great impression it made upon him when Professor and Mrs. Pickering returned from the White Mountains and opened their home to entertain him. "For," he remarked, "I was then a young man totally unknown."

Descriptions of these early journeys given in *The Observatory* under the title, "Some Longitude Trips" (translated by the French, "*Erreurs* de Longitude," he adds!) resemble closely the tone of the later "Oxford Note Book."

Other visits to this country occurred in 1896 when returning from the Japanese eclipse, in 1904 for the St. Louis Conference, in 1910 for the Solar Union, in 1927 for the Rumford medal, honorary doctorate, and lectures at the University of California, and finally in 1928, when he was the delegate from the British Association to the American Association for the Advancement of Science at the New York meeting. Of that visit, he wrote, "It has been a full trip, but a joyous one."

Professor Turner was married in 1899 to Agnes Margaret Whyte, daughter of Robert Whyte of Pentland House, Lee. Their only child is Dr. Ruth Turner of St. Mary's Hospital, London. Mrs. Turner accompanied her husband to this country in 1904, 1927, and 1928, and has many friends on this side of the Atlantic. On sailing away in 1927, she wrote of the "splendid trip" and their sadness "at leaving America where we have had such a glorious time, renewing so many friendships and making fresh ones." An ideal companion, Mrs. Turner seemed equally at home as private secretary to her husband, or planning the delightful humanizing dinners they were wont to give at New College Fellows' Hall after a technical Halley lecture, or acting as hostess to visiting astronomers. How many of us when going to the Mother Country have enjoyed the charming hospitality of Professor and Mrs. Turner at Huntercombe, their Oxford home, where the latch string was

always out and nothing ever seemed to be too much trouble! Such cicerones were these two, whether it were punting on the Cherwell, bicycling to the Cotswold, taking tea baskets to Blenheim Castle, attending garden parties in beautiful College gardens, or seeing the treasures of Oxford University! Can any guide to New College ever equal this modern Wykemite? Many of us, I am sure, have been escorted by him up those narrow old stairways to see the antiquities of this college which in 1379 was christened New College.

Always active physically, he was a devotee of various forms of exercise, such as grass-rolling, cricket, walking or bicycling, the last two methods of locomotion being greatly preferred to motoring. A couple of years ago, it was interesting to see him take part in the annual cricket match between the Dons and Choir Boys of New College.

A firm believer in woman's "rights" and in woman's ability, he was always ready to give women a helping hand. A mistress of a woman's college in Cambridge, England, once remarked that she hardly thought women had as many privileges or quite the same standing in that University, as the women had at Oxford. When some asked why, she replied, "We have not had a Professor Turner to work for us."

He was greatly interested in the Harvard Astronomical Fellowships for women, as described in Circular 214. Apropos, he wrote on May 13, 1919, "The following idea may be worthless but I put it before you as a chance. It might be possible (let us say as a friendly act at the present moment of great events and important new departures) to assign one of the Fellowships to an English woman. I need scarcely point to the advantages which such action would have, both in encouraging women's work generally, in cementing friendly relations between the two nations, and in creating a new form of recognition. Such acts would carry great weight."

As a consequence of this suggestion, Professor Bailey, then Acting Director, awarded the Pickering Fellowship for 1919 to Miss Grace Cook, an English meteor observer.

For many years engaged in seismological investigations, the death of John Milne in 1913, left Turner (as Chairman of the Seismological Committee of the British Association) in charge of the earthquake station at Shide, and of about forty British stations. In 1918 the plant was removed to Oxford, which then became the world center for such work, where records were received from many countries, and bulky reports were issued each month or quarter. This work occupied a great deal of his time, although he had the efficient assistance of Miss Bellamy. He gave much study to the earthquake waves, finding a certain periodicity in their recurrence, and concluded that their depth proved the earth to be of a rocky nature nearly half-way to its center.

His mathematical lectures continued year after year, and large numbers of more popular lectures were given to parties of students and teachers at the Observatory, or elsewhere, among which may be especially mentioned the Christmas course of Juvenile Lectures at the Royal

Institution in London, which he gave four times.

Professor Turner never lost his interest in the Astrographic Catalogue and was constantly regretting its rather slow progress at the various world-wide observatories. The Oxford zone, despite the limited resources of the University Observatory, was, after Greenwich, the first one of the huge Catalogue to be published. To help matters along, in 1912 he took over the completion of the Vatican zone, which he put under Mr. Bellamy's care. He also aided materially in the progress of the work at Santiago and Hyderabad. As Chairman of the Committee of Organization of the whole work, under the International Astronomical Union, he was always urging by words, and promoting by deeds, the completion of the great project. He devoted much time and thought to a study of photographic magnitudes, and his numerous papers, on "A Proposal for the Comparison of the Magnitude Scales at the Different Observatories Taking Part in the Astrographic Catalogue" brought together valuable material on stellar distribution.

A glance at the titles of the many short papers and notes Professor Turner published, generally in the *Monthly Notices*, causes one to wonder whether there was any celestial or geodetic topic on which he did not have ideas. Alert for a new conception, he noted that the image of a bright star near a réseau line on an Oxford plate, appeared to distort the line. Is there then, he wondered, an attraction between photographic images? If so, spectral lines might be displaced. A connection between the Leonid meteor stream and the sun-spot period, discontinuities in weather phenomena, and periods in earthqquakes, were subjects for investigation. The classification of long-period variables by the harmonic analysis of their light curves was for years one of his favorite methods of research.

But statements concerning harmonics, periodograms, discontinuities, co-ordinates, or stellar magnitudes do not satisfy us in the consideration of a personality such as characterized Professor Turner. It is the warmth of his friendliness, the human approachability, the kind heartedness, which is the uppermost thought. What endless trouble did this humanitarian take to help people or to win them recognition. From many examples, I can cite but a few: A little Oxford girl twelve years old, thought of the name Pluto for the new planet and eagerly consulted Professor Turner who used his influence for the adoption of the name, even cabling the suggestion to America; a strange American lad discouraged at his inability to enter Oxford owing to late registration, called at Huntercombe, armed with a letter of introduction from an astronomical friend at home to Professor Turner, who wrote to or interviewed the heads of all the Oxford colleges until the lad was admitted; the poor people near the Oxford station unable to afford clocks or watches were at a loss for knowledge of the time, because the face of St. Thomas' clock had weathered so that the hands were invisible, until Professor Turner had the repairs made at no little expense to himself (the city refusing to do it), for, said he, "Being an astronomer I could

not bear to think of people not being able to get the time."

To aid in bringing the University into closer touch with the people, he served for twenty years on committees with the Workers' Educational Association, and helped to organize the Tutorial Classes, a form of University Extension now wide-spread in England. He won the complete confidence of the working class Committees and often visited the classes in distant places, to meet the students or to give them a lecture. Whether speaking to crowds of miners in North Staffordshire or to the members of the Summer School of the Tutorial Classes in the University Observatory, he never failed to interest them in his own happy way with its amusing point of view.

His vivid power of popular exposition is well shown in his books, *Modern Astronomy, The Great Star Map, Astronomical Discovery,* (from six lectures given at the University of Chicago in 1904), and *A Voyage in Space* (six Christmas lectures at the Royal Institution).

Honorary doctorates were bestowed upon him by the Universities of Leeds, Sydney, Wales, Strasbourg, Durham, and California. He was a Fellow of the Royal Society, and of New College. He was a Correspondent of the Institute of France, and an Honorary Member of the American Astronomical Society. The Bruce Gold Medal of the Astronomical Society of the Pacific was awarded him in 1927, "for distinguished services in Astronomy."

His spirits, naturally gay, could, however, bear up under disappointment. What if the much advertised Leonid shower of meteors failed to appear in 1899? The Oxford boys, one or more from each college to give the alarm in case of a great display, who carpeted the Observatory floor for several nights, could burst forth in verse

"They'll come whene'er their fancy bids
The Leonids, the Leonids"

while Professor Turner pithily remarked, "The Leonids are late at the cross-roads." What if false hopes were sometimes raised concerning general appreciation of astronomy? Thus, upon entering a shop to purchase a book which from the street appeared to be on the interesting subject, "Astronomy as a Fine Art," he found alas! that one letter had been covered up, and the book was entitled, "Gastronomy as a Fine Art."

As compensations, were there not many astronomical folk to be near to his heart? Witness his delight when Oxford conferred the honorary Doctor of Science upon Mr. Knobel at the age of eighty-six. Think of his many years of friendship with the daughters of Sir John Herschel of the famous Observatory House in Slough.

My readers will pardon me, I trust, if perchance I have stressed the human side of this man of the stars. For, although his life-work consisted largely in mathematical lectures and statistical studies of distant bodies, yet he was so genial and gay, so genuine and warm hearted, so full of understanding and helpfulness, that his friendliness must have

been to many people one of the abiding joys of life, as it has been to the author of these lines since 1904 when a better acquaintance arose from a discussion and correspondence concerning the period of S Lacertae.

He will long be sadly missed, this friend of humanity, "so noble a character, so mighty of pure friendship."

HARVARD COLLEGE OBSERVATORY, CAMBRIDGE, MASSACHUSETTS.

A FREE PENDULUM CLOCK*

By L. JACKSON BULLIET

The description and discussion below are concerned with a suggested design for a clock in which the recording and maintaining processes would be applied to the pendulum without disturbing the free period of that pendulum. At least, it is hoped that the disturbance would be reduced to a practical minimum by this method.

It should be pointed out in the beginning that the present description attempts to set forth only the principles and theories involved and is not intended to give directions for the actual construction of a clock. The drawings do not even illustrate the structural features of the preliminary model already built because it was thought best to keep the diagrams as simple as possible for the sake of clarity. It should be further noted that this is not an endeavor to solve any problems of the design of the pendulum itself. For the present purpose, the pendulum will be assumed to beat seconds perfectly. Then the clock itself can, of course, be no better as a timekeeper than the pendulum which regulates it. However, it is believed that the worst errors of present clocks are caused by the recording and maintaining mechanisms and that pendulums are now available which would keep well nigh perfect time if allowed to swing undisturbed and under the conditions of constant temperature and barometric pressure.

*NOTE: Since the preparation of the following paper, the writer has become aware of the fact that other experimenters have worked out clock designs which involve the use of a photo-electric cell in some such manner as is discussed in this paper. However, he does not know of any other clock which uses the method of maintaining the pendulum's motion which is here brought out, so the latter is the reason for the present offering of the paper. The writer did not consider it wise to rewrite the discussion leaving out the matters pertaining to the photo-electric cell because that would necessarily destroy the completeness of the description. Anyway, the use of the photo-cell as set forth here probably has some unique features which make it better adapted to this particular clock design than would be the schemes worked out by others.

Mention should also be made of the fact that a preliminary model of this clock has been constructed. The model was not made with sufficient accuracy to serve as a timekeeper, but it did involve all the physical principles used in the pendulum drive and in the slave-clock regulation and seemed to bear all these out as being sound as applied.

The matter of recording the strokes of the pendulum will be looked into first. Figure 1 shows the pendulum, *P*, swinging in the plane of the paper with the small plane mirror, *M*, mounted rigidly on its stem. Light from the two small lamps, *L*, passes (after being diffusely reflected from the surface, *V*) through the small aperture, *A*, which acts as a point source of light, then goes through the condensing lens, *B*, falls upon the mirror, *M*, and is reflected to a focus on the opaque shield, *O*. There is a tiny opening, *C*, (the size and position of this opening should be adjustable) in the shield, *O*, so that a momentary flash falls upon the photo-electric cell, *D*, each time *P* passes through its vertical position. The output of *D* is amplified by the grid-glow tube amplifier (Westinghouse Product), *E*. The grid-glow tube is used rather than the regular vacuum tube amplifier because this tube has no filament to burn out and cause failure of the recording apparatus. The grid-glow

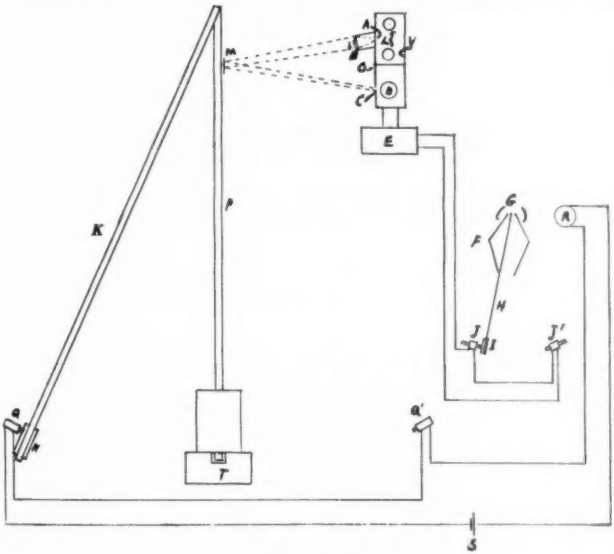


FIGURE 1.

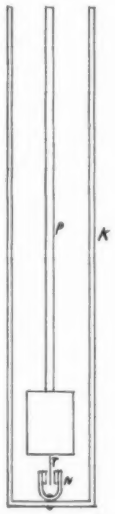


FIG. 2.

tube has a limited life but that life has a rather definite length and a change could be made in plenty of time to prevent trouble due to decreased efficiency of this unit. It would seem that the wire filament of a regular vacuum tube would be considerably more unreliable as it is subject to shock and overload as well as deterioration. The need for reliability also accounts for the two lamps illuminating the source aperture, *A*, rather than just one. Each lamp should be of sufficient candle power to actuate the photo-electric cell so that, if one should go out, the other would carry on the operation of the clock until the dark lamp would be noticed and replaced.

At F is indicated a standard gravity-escapement clock made for a seconds pendulum. The provision for raising the bent arms, G, by means of the clock train should be removed and the seconds pendulum should be replaced by a half-seconds pendulum, H, (the reason for H being of this length rather than any other length giving a period less than one second will be explained later). With these modifications made, the clock hands will move up one second every time H swings from one side to the other but there is no way that the clock train can keep H in motion. The bob, I, of H should be made of soft iron. J and J' are small permanent bar magnets spaced equally on the two sides of the vertical position of H. On a soft iron extension of each of these magnets is wound a coil of many turns and these coils, after being hooked in series with each other, are connected to the output of E. The windings must be in such a direction in each case as to oppose the permanent magnetism of J and J' when a current from E passes through them. Now supposing I held over against J as shown. P passes through its mean position thus sending an impulse via D and E to J and J'. This releases H and allows it to swing over and free the clock work to move up one second. H would not, of itself, rise as high as J' because of damping. But, during the swing of H, the current in J and J' has ceased and the magnetism of J' is sufficient to draw I up to it. Hence, since this occurs in the opposite direction on the next swing of P, it is seen that one second is recorded on the clock for each swing of the pendulum, P.

It is perfectly clear that all this cannot in any way disturb the going of the fundamental pendulum since that pendulum has no work to do. It should be further pointed out that errors arising from imperfections of the clock proper cannot accumulate. It is seen that H is stationary for a half of every second so that it starts anew with each succeeding impulse from P. Suppose H should be retarded a little in its swing by dirt in the mechanism, by a change in temperature, by a weakened current from E causing a belated release or by any other cause; suppose this causes the time when H releases the time-train to be late by an interval, dt, which would necessarily be very small unless there were something radically in need of repair. Now the second in question will be recorded late by an interval dt but the next second will be recorded dt late (for the same reasons) and not $2\,dt$ because H will have come to a full stop in the meantime. Thus it is seen that while imperfections of the gravity-escapement clock may introduce an error into the single readings they cannot introduce a growing error and the rate of the complete clock can be only that of the fundamental pendulum, P, which is assumed to be zero or constant. It is believed that clocks are now available which will not introduce detectable errors into the single releases of their trains and which would thus be suitable for use as a slave-clock in such an arrangement as this. The magnetic rather than mechanical release for H was devised so that dt would not be increased by the irregularities of the time of action in mechanical catches or hooks so

susceptible to frictional wear and dirt. It is, of course, clear that the same things that have been said of a cause tending to slow H down will apply equally to a cause tending to speed the motion of H.

The next requirement is for a means to maintain the motion of the fundamental pendulum, P, at practically a constant amplitude. From Figure 1 and from Figure 2, which is a view looking at the left side of Figure 1 but omitting the optical, electrical, and slave-clock units, it is seen that K is a rectangular frame so mounted that it swings about the same geometrical axis (though not from the same support on account of jarring P) as the pendulum. In the center of the lower cross piece of this frame, is mounted the strong permanent magnet, N, with its poles pointing upward. The pole-pieces of N are very close together so as to produce a very strong field between them. K is normally held back to a position far beyond the extremity of swing of P as shown in Figure 1. The method of holding it back is shown in Figure 3 which is a top view of N and the two-pole electro-magnet, Q. The cores and yoke of this electro-magnet form a keeper for N so that K is held back by the attraction of N for Q. Now, at the end of an interval between impulses to the pendulum (say one or two minute intervals), the wheel, R, geared to the clock movement for proper timing, will send a current from the battery, S, through Q and Q' which are alike. This current goes in such direction as to oppose the attraction of N for Q and so K is released to swing past P (Figure 2 shows them at the moment of passage looking from the left) over toward Q' which is the same distance from the vertical position of P as is Q. Ordinarily, K would not

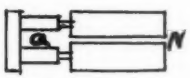


FIGURE 3.

swing as far as Q' on account of damping and N would likely not be strong enough to finish the stroke with its attraction for Q' because of the great amplitude and hence considerable damping. For this reason, Q and Q' should be wired so that the same current that causes the release at Q will cause a little attraction at Q'. Then, at the next time for an impulse, R should send the current in the opposite direction through Q and Q' so that K would return to its position at Q.

Going back now to investigate what happens during a swing of K, it is seen from Figures 1 and 2 that there is a copper (or other non-magnetic conductor) plate, T, supported below the bob of P with its faces parallel to the plane in which P is swinging. Figure 2 shows that this plate passes through the magnetic field between the poles of N as K swings past the pendulum. K should have its mass so distributed that, though it is longer than P, its period is the same as that of P. Since the periods are the same but the amplitudes very different, K will pass P at the center of the swing but K will be going considerably faster

than P. Thus there will be a relative motion between N and T so that eddy currents are generated in T. By Lenz's law, these eddy currents will set up a field tending to oppose the motion of N and there will, therefore, be a drag or pull on P due to the motion of K. K, however, goes on and T is soon out of the influence of the field of N, and P is free once more. These impulses must come an odd number of seconds apart so that they will always be in the direction in which the pendulum is going at the time.

It seems that this method of keeping up the amplitude of the pendulum would overcome the most serious difficulties met with in other methods. First, there is no chance for wear or changing conditions of friction as exists where two surfaces come together in giving a mechanical impulse. Then the impulse here is entirely in the direction of swing of the pendulum so that the suspension does not have to sustain any downward thrust. There is no chance of causing vibrations by jarring the pendulum as the impulse is given because the propelling force will build up gradually as T comes into stronger and stronger parts of the field of N, then it will die away in the same manner. Varying viscosity of oil cannot become a factor as when a lubricated crutch presses upon the sides of the pendulum stem.

It remains now to test the soundness of this method of maintaining amplitude against Airy's two conditions for a maintenance which would not disturb the timekeeping of a pendulum directly even though the impulse itself might vary slightly. These conditions are that the pendulum must be free at and near the ends of its swings and that the maintaining impulse must be applied symmetrically with respect to the vertical position of the pendulum. Compliance with the first of these conditions lies in keeping the amplitude of K large with respect to that of P. The space between the pole pieces of N is so small that the magnetic flux is almost all directed straight across it so that, when K gets out considerably beyond P, T will be in practically no field from N. Moreover, K and P will both be going so slowly near the ends of their swings that the relative motion will be greatly diminished thus farther reducing any effect K might exert on P near the end of a swing. Then, when N comes to rest upon a keeper, its field is shunted around through that keeper, eliminating any stray field that might otherwise cause a damping effect as the pendulum gathers speed on its return. Should it be found that the weak field and diminished relative motion are not sufficient to satisfy Airy's first condition, a massive iron shield could be provided so that N would swing up under it thus shielding T from N.

In considering Airy's second condition concerning symmetry of impulse, it is known that any pendulum swings with the same velocity at any given distance on either side of the mean position, so that for corresponding positions of K and P on the two sides of the mean, the relative velocities will be equal (except for a tiny change in the two velocities due to the transfer of energy from K to P). Even this error could be wholly eliminated by adjusting the time of releasing K so that P

would reach the vertical position a trifle ahead of K. This would make the impulse a little longer in time on the far side where the force is weaker. The geometrical symmetry of the impulse would be disturbed but the force symmetry maintained. Since the impelling force depends upon this relative velocity and since K passes P at the center of swing, it follows that the impulse must have the required quality of symmetry.

It should be noted that K would not have to be a high quality pendulum because it swings but once at a time and small changes at its supports or variations in its length due to expansion could not affect its period enough to cause trouble during this one swing.

It may now be explained why H should be a half-seconds pendulum. R will throw in a contact on the proper second as the time train is released. Since K and P are to pass at the middle of the swing, K must be released just as P leaves its extreme position. That is, R must move exactly one half second after P passes its mean position. This is accomplished by making H a half-seconds pendulum so that it frees the time train to move R just one half-second after it has been itself released by the impulse from P.

Another point to which the reader's attention should be called is that the accuracy of the clock will not depend upon the constancy of any outside source of electrical current. Storage batteries should be used at S and to supply current for L and E and, so long as these batteries supply currents above certain minima, the clock will carry on its functions. Variations in the supply to E cannot cause cumulative errors as has been explained already. Changes in S might cause trifling variations in the time of releasing K but this variation would be a very small part of K's period and it could not accumulate just as it has been explained that other disturbances of K could not make a cumulative error in the magnitude or time of the impulse to P. The strength of the impulse given to P depends upon the constant distance Q or Q' to the center and upon the pole strength of N. N should be made of the very best steel as regards permanency of magnetism but there is the further assurance against variation here that N has a keeper the great majority of the time and that the demagnetizing effect of the little current used in releasing it should be counteracted by the equal magnetizing effect used in pulling it up to its keeper on the other side. Since Airy's conditions are apparently fulfilled, small variations in the impulse would not have a direct effect on the timekeeping anyway. However, it is important to keep the impulses as nearly equal as possible because larger or smaller ones would finally change the amplitude enough to introduce error due to the fact that a pendulum swinging in a circular arc is not perfectly isochronous.

317 East Third Street, Bloomington, Indiana.

AN AMATEUR'S OBSERVATORY AT LOW COST

By NICHOLAS IEDEMA.

What amateur does not wish on a cold windy night to have a comfortable observatory with a dome instead of being exposed to the elements under the open sky? Perhaps those living in more southern latitudes with milder climate do not feel so much the need of an observatory as we do here in the north. However, as we pass from our first 3-inch on a tripod to larger and heavier instruments it is time and labor saving to have a building where the telescope may be kept permanently instead of carrying it in and out of the house whenever we wish to use it. I will explain how I solved this problem, but the photographs herewith tell the story better.

When I bought this place where I am now located, a building with a flat roof was found in the backyard. Formerly a horse was kept in it. Later a motorcar. The size was 9x18 feet. I decided to make a combination observatory and chicken house out of it.

First a partition was built dividing the building in two equal parts, the front half intended for observatory. The building was somewhat strengthened here and there as a former occupant chewed away the greater part of the two-by-fours for lack of oats. A revolving dome seemed for me too difficult to build at the time so I decided to raise the roof of the observatory and have it slide on top of the chicken house when open. This was easily done with little cost and labor by laying two tracks and fastening wheels underneath the roof of the observatory. (This sliding roof may still be seen in the photograph.) A brick pier was built in center of observatory and a telescope mounted. I set the telescope rather high as our place is surrounded by other buildings and I wanted to reach as low an altitude as possible. A platform was built around the pier, taking care not to touch the pier.

In order to be able to close the roof, the telescope had to be in a horizontal position. When pointed at the zenith I could just reach the eyepiece of my reflector by standing on tiptoes.

The telescope was now permanently set. I did not have to carry the instrument around any longer. However, things were far from satisfactory. If I had been using a refractor where the eyepiece is at the lower end of the tube I might have left things as they were. As the eye end of the reflctor is at the upper end of the tube, there still was very little protection for the observer on a windy night with thermometer around zero. Also street lights interfered a great deal by shining in one's eye as he was trying to see a faint variable or other difficult object. I tried to overcome this defect by tying two or three umbrellas here and there on the observatory (a queer looking sight, by the way, as the neighbors testified; fortunately it was always night time). How-

ever, I made the best of it at the time, thinking in the meantime how to construct a revolving dome some day.

About this time there appeared an article in POPULAR ASTRONOMY, by Mr. J. Ernest G. Yalden, one of our members of the A.A.V.S.O., on how to build a revolving dome. After reading and studying this article I saw my way clear how to go about it.

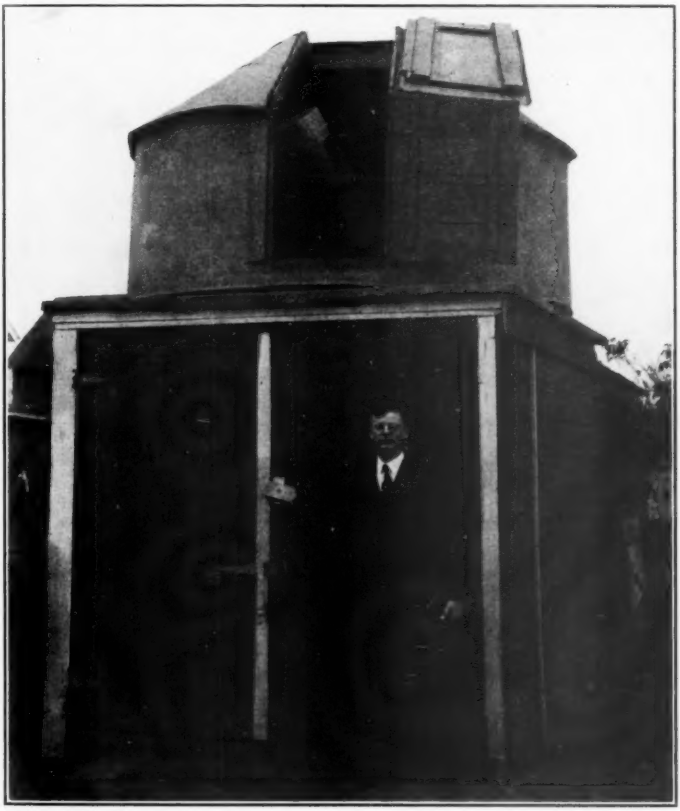


FIGURE 1.
MR. IEDEMA'S OBSERVATORY AND 10-INCH REFLECTOR.

An old building was torn down in the neighborhood and I was presented with a great deal of sheetmetal, enough to build my dome. The ring of wood or base of dome seemed the most difficult part to make so I started there first. If that did not turn out right I would not have to do the rest. This ring consists of three layers, each layer one inch thick, held together with wood-screws. Each layer is in separate pieces.

These pieces are lapped one-third their length, and were cut in a sawmill to the desired curve after I made the first pattern.

I was delighted after I screwed the last piece of curved board into place to have a strong base for my dome. Six wheels were placed on this ring. A platform was built on top of the observatory, the outside square with the building and inside round even with the base of the dome. The platform consists of two layers of one-inch board cut out by hand. On this platform the dome revolves. It cannot roll off as four wheels fastened on the base of the dome and rolling around the inside of the

FIGURE 2.
PLATE HOLDER ATTACHED TO 10-INCH REFLECTOR.

platform keep the dome centered. Some hooks fixed in a similar manner keep the dome from blowing off. A light framework of 2- and 3-inch thickness is built on the revolving ring and the sheetmetal fastened onto this. Those skillful in metal work may dispense with the wooden frame work, the seams of the sheetmetal holding up the dome.

The opening has three doors. One at a time may be opened, leaving the others closed if so desired. A lantern placed in a wooden box with a small hole in front for light to pass out illuminates charts. A flashlight is kept handy for reading circles and hunting lost things. We

also have an observing chair, the seat of which may be lowered or raised as the case may require. It is always in the way and the tube usually bumps against it in the dark, as I have not any too much room. However, when I become tired it is useful. A slideholder is shown in one of the photographs, fastened on the eye end. By pushing the plate along this slide three photographs of the moon may be taken on a plate 3¼ x 4¼ inches. Exposures are made by lifting the cover of the telescope and replacing it.

The dome has been in use for five years, and no repairs or alterations made during that time. It was built by myself in spare time. It may not be perfect nor as handsome as a made-to-order affair, but considering its low cost it serves its purpose as well as we may expect it to.

GREAT NECK, LONG ISLAND, N. Y.

BODE'S AND SIMILAR EMPIRICAL LAWS

By C. C. WYLIE.

The discovery of the planet Pluto, apparently at a distance from the sun closely represented by the Bode-Titius law may renew interest in that celebrated representation of planetary distances. This may be an appropriate time to point out that satellite, as well as planetary, distances are well represented by Bode's and certain similar laws. One such law was published about a year ago by Dr. A. E. Caswell[1] of the University of Oregon. Dr. Caswell pointed out that "the mean distances of the planets from the sun are proportional to the squares of simple integral numbers." His suggested law represents the distances of the planets in astronomical units by $0.0425\ n^2$, where n is a simple integral number. The distances of the four inner planets, Mercury, Venus, Earth, and Mars are well represented by the successive integers 3, 4, 5, and 6. Beyond Mars the series gives too many numbers; but the distances of the known planets correspond fairly well to numbers in the series. In a later paper read at a meeting of the American Association for the Advancement of Science, Dr. Caswell informed us that this law had been noticed some ten years ago by Dufton in England. He also points out that the energies of the planets appear to fall into three distinct orders of magnitudes and that within a given classification the energies are approximately proportional to simple integers.

Another discussion was published in *Science* by J. B. Penniston.[2] Mr. Penniston quotes Victor Goldschmidt, of Heidelberg, as showing that "a mathematical treatment strictly analogous to the phenomena of *standing waves in sound*, the distribution of lines in spectra, the progress of crystallization and similar phenomena gives the same law of

[1] *Science*, n. s. **69**: 384, 1929.
[2] *Science*, n. s. **71**, 512, 1930.

harmonic relations of distances not only for the planets but also for satellites."

Using these laws Goldschmidt represented the distances of the planets in astronomical units as: Mercury 0.39; Venus 0.71; Earth 1.0; Mars 1.67; Jupiter 5.0; Saturn 10.0; Uranus 20.0; and Neptune 30.0. Following Goldschmidt's method Penniston obtained for Pluto, 40.0.

Dr. Caswell followed the analogy of the Bohr atom in deriving his law, and remarked that this suggested the possibility that the orbits of the planets may be "quantized." Penniston treated the solar system

TABLE.

System	Satellite	Distance	Bode	Caswell	Penniston
Sun	Mercury	0.39	0.4	0.38	0.3
"	Venus	0.72	0.7	0.68	0.6
"	Earth	1.00	1.0	1.06	1.0
"	Mars	1.52	1.6	1.53	1.5
"	Ceres	2.77	2.8	2.72	2.8
"	Jupiter	5.20	5.2	5.14	5.5
"	Saturn	9.54	10.0	9.56	9.1
"	Uranus	19.19	19.6	18.7	19.0
"	Neptune	30.07	....	31.0	30.0
"	Pluto	39.6	38.8	40.8	40.6
Mars	Phobos	0.40	0.4	0.38	0.3
"	Deimos	1.00	1.0	1.06	1.0
Jupiter	V	0.30	0.4	0.38	0.3
"	I (Io)	0.63	0.7	0.68	0.6
"	II (Europa)	1.00	1.0	1.06	1.0
"	III (Ganymede)	1.60	1.6	1.53	1.5
"	IV (Callisto)	2.80	2.8	2.72	2.8
"	VI	17.10	19.6	17.0	17.1
"	VII	17.52	19.6	17.0	17.1
"	VIII	35.10	38.8	35.7	35.1
"	IX	36.00	38.8	35.7	35.1
Saturn	Mimas	1.00	1.0	1.06	1.0
"	Enceladus	1.29	...	....	...
"	Tethys	1.59	1.6	1.53	1.5
"	Dione	2.04	...	2.08	2.1
"	Rhea	2.84	2.8	2.72	2.8
"	Titan	6.60	5.2	6.12	6.6
"	Hyperion	8.00	10.0	8.31	7.8
"	Iapetus	19.2	19.6	18.7	19.0
"	Phoebe	70.0	77.2	71.4	70.3
Uranus	Ariel	1.00	1.0	1.06	1.0
"	Umbriel	1.47	1.6	1.53	1.5
"	Titania	2.28	...	2.08	2.1
"	Oberon	3.06	2.8	2.72	2.8

more like the Schrödinger atom, using wave-theory, and obtained a law which represents the distances of the planets in astronomical units as $0.05\,n(n+1)$, where n is a simple integer. This law represents the distances of the four inner planets, Mercury, Venus, Earth, and Mars by the successive integers 2, 3, 4, and 5. Beyond Mars this series, like the Caswell series, gives too many numbers, but the distances of the known planets correspond fairly well to numbers in the series. Mr. Penniston pointed out that Bode's law gives a fairly good representation of the distances of many of the satellites in the solar system, a

fact overlooked in nearly all modern popular discussions although he states it was referred to in some articles about fifty years ago. He includes a table illustrating the application of Bode's law, Caswell's law and his own law to the planets, and to the satellite systems of Mars, Jupiter, Saturn, and Uranus.

In the accompanying table, the first column gives the distances for the planets in astronomical units; the second column, the figure by Bode's law; the third column, the figure by Caswell's law; and the last column gives the figure computed by Penniston's law.

For each of the satellite systems the columns are the same except that the first gives the distances in terms of the mean distance from the planet of one of the satellites. For Uranus and Saturn the distance of the nearest known satellite is adopted as unity. This is not done for Jupiter and Mars whose inner satellites are near Roche's limit. For Jupiter the distance of Satellite II is adopted as unity, and for Mars the distance of Deimos is adopted. This table is similar to that published by Penniston.

Dr. Caswell stated that "on the whole the agreement is good, and can scarcely be accidental." Penniston offered it as his opinion that "Bode's law, as a first approximation may have its origin in actual causal phenomena." On the other hand many astronomical writers are inclined to believe that it is merely a coincidence. Professor Jacoby has written in his textbook "The table shows that the law is quite accurate until we reach Neptune; then the error increases suddenly; and we must conclude that the whole thing is one of those rare and remarkable coincidences that nature sometimes provides, apparently to mislead scientific investigators." Dr. Jeans in his book *The Universe Around Us*, ventures the opinion "* * * it seems more than likely that it (Bode's law) is a mere coincidence with no underlying rational explanation." With the evidence at hand, the opinion of some good scientists is that the arrangement of the solar system has nothing to do with quantum theory or the Schrödinger atom; but they observe with interest that the distances of the inner planets are so nearly proportional to the squares of successive simple integers, that the same distances are well represented by successive simple integers on Penniston's law, and that Bode's law and these laws give a good representation not only of planetary distances, but also of the distances of the four bright satellites of Jupiter and nearly all other satellites in the solar system. They readily grant that these facts have a strong psychological appeal, and suggest that the arrangement is not accidental.

NOTE ON THE ORBIT OF EROS

By A. O. LEUSCHNER and H. THIELE.

A review of the investigations of the orbit and perturbations of Eros reveals a wealth of fundamental data of permanent value and great importance for accurate prediction, comparison of theory with observation, and improvement of our present knowledge of the motion of the planet.

Accurate computations of the orbit of Eros appear to have ceased with the work of Witt and Noteboom. The latter, continuing Witt's work, which took account of the perturbations of all the major planets with the exception of Mercury, Uranus, and Neptune, supplied the general perturbations of Eros by these three planets, computed an ephemeris for the Sun to 8 decimals and determined the perturbations of the barycenter. The orbit improvement and a determination of the Earth-Moon mass was made from 24 normal places, 1893-1914, starting with Witt's latest set of elements, and gave a mean motion of 2015″.275271. The resulting mass of the Earth, 1 :328370, and parallax 8″.799 represented the normal places within 0ˢ.2 and 2″, yet a run in the residuals for 1898-99 and 1900-01 was unmistakable.

Further orbit improvement must depend to a considerable degree on renewed study of the observations. Witt's previous elements, based on observations of 14 years to 1907, representing 8 revolutions and 7 oppositions, exclusively of the perturbations of Mercury, Uranus, and Neptune, had represented subsequent observations as follows:

1910·	1912	1914
+0ˢ4	—0ˢ4	—0ˢ3
—1″	+2″	—2″
95°	179°	260°

Since then, apparently only approximate ephemerides have been computed with approximate perturbations. The representation of some late oppositions is as follows:

	1921	1926	1928
$\Delta\alpha$	+0ᵐ4	+0ᵐ2	+0ᵐ5
$\Delta\delta$	+4′	+1′	+4′
M	246°	154°	234°

Available for the coming opposition 1930-31, is an approximate ephemeris by Witt giving α to 0ᵐ.1 and δ to 1′. This ephemeris, originally published in No. 5375 of the *A.N.*, appears also in *Kleine Planeten*, 1930.

The mean motion of the planet is probably now known to 0″.0005. With this mean motion and the accurate available developments of the general perturbations by various investigators [Russell, Merfield (secular perturbations), Samter (most extensive study of the general perturbations of all the major planets except Mercury, Uranus, and Neptune)] the long series of hitherto unused observations should prove

fruitful in revising the motion of the planet, the solar parallax, the Earth-Moon and other masses. In this connection, of course, the present campaign of observation of Eros and the comparison stars will be of utmost significance. A bibliographical and historical record of past researches on the motion of Eros, etc., is contained in our Research Survey of Eros. Copies can be furnished to anyone interested.

SEPTEMBER 3, 1930.

Postcript dated December 23, 1930:

Since the writing of the foregoing note, continuations of Witt's accurate computations have appeared in *A.N.* 5729, 5736, 5743, and 5753.

An accurate ephemeris computed from solar coordinates of *B.J.* 1930, with Noteboom's elements and special perturbations by Venus, Earth, Mars, Jupiter, and Saturn, and secular perturbations by Mercury, Uranus, and Neptune, gave $\Delta\alpha = -3^s.5$ in 1928. Observations by G. Struve gave $\Delta\alpha = -7^s.41$ and $\Delta\delta = -9''.4$ for 1930 August 28.0.

The latter residuals are completely removed by the empirical correction $\Delta M = -74''$. The ephemeris is continued with this correction from 1930 November 0.0 to 1931 January 32.0, accumulated perturbations being neglected beginning October 14. Further observations by G. Struve gave for the correction to the ephemeris on November 2.0, $\Delta\alpha = -1^s.01$, $\Delta\delta = +4''.7$.

In view of the fact that M, ω, and ϕ probably will require further correction, Witt points out the provisional character of the ephemeris.

A. O. L.

AMERICAN ASTRONOMICAL SOCIETY

REPORTS OF OBSERVATORIES
1929-1930

The reports which follow are for twelve months ending June 30, 1930, unless otherwise noted.

ALLEGHENY OBSERVATORY

UNIVERSITY OF PITTSBURGH

PITTSBURGH, PENNSYLVANIA

(July 1, 1929, to October 15, 1930)

A. *Stellar Parallax.* The number of plates taken with the Thaw Photographic Refractor is now approaching 43,000, of which about 80% are parallax plates and the remainder are on Mr. Jordan's program of extra-focal photometry of faint variable stars. Nearly five hundred parallax regions are now completed and awaiting measurement. Though the goal of a mean probable error of 0".005 has not quite been reached,

a list of fifty parallaxes by Miss Esther M. Doody (in press) has a mean probable error of 0".0052.

B. *Extra-focal Photometry.* Satisfactory progress continues in Mr. Jordan's extensive variable star program; his current observation program comprises about one hundred variable stars, with representatives of all classes of stellar variability.

C. *Spectrographic Researches.* Mr. Burns, in coöperation with Dr. F. M. Walters, Carnegie Institute of Technology, is carrying on an extensive investigation of the accurate wave-lengths of the spectra of iron, copper, and cobalt, employing interference methods.

D. *Miscellaneous.* Preparations are being made for intensive observation of Eros at the coming opposition, in coöperation with Greenwich and other observatories.

Mr. Curtis set up an eclipse camp about thirteen miles northwest of Gerlach, Nevada, on the border of the Smoke Creek Desert, for the observation of the curious, very short total solar eclipse of April 28, 1930. A grating spectrograph and a prism spectrograph were planned for the infra-red flash spectrum, and Judge Henry S. Hulbert, of Detroit, also mounted a movie camera and other photographic apparatus on the polar axis. As shown by cusp observations made before and after the eclipse by Dr. Dozier, of Red Bluff, California, and by the duration of the short "flash" of darkness, it is believed that the camp was located within 250 feet of the central line. Thick clouds, however, prevented any observations.

Over six thousand visitors have been received in the Frick Public Evening Service of the Observatory, in charge of Mr. Wm. R. Ludewig.

E. *Personnel.* Mr. Curtis resigned, as of date of October 15, to become Director of the University Observatory and Head of the Department of Astronomy of the University of Michigan. Mr. Frank C. Jordan was appointed Director on this date, and Mr. Keivin Burns Assistant Director.

HEBER D. CURTIS, *Director.*

BUREAU OF STANDARDS

DEPARTMENT OF COMMERCE

WASHINGTON, D. C.

The spectroscopy section of the Bureau has devoted the greater portion of its efforts during the past year to the establishment of the chemical origins of the many faint lines yet unidentified in the solar spectrum and constituting more than 40 per cent of those given by Rowland. This requires not only the careful remeasurement of many emission spectra, but also the analysis of these spectra into their term structures. New wave-length measurements have been made in the arc and spark spectra of columbium and the rare earths ytterbium and lutecium. Comparison

of these new wave-lengths with those of the sun, given in the Revised Rowland, has confirmed previous identifications and has yielded new ones. Analyses of spectra into their term structures have been carried forward for the arc and spark spectra of chromium, zirconium, lanthanum, and hafnium, the work for zirconium and lanthanum being practically completed. From the terms which have been found for these spectra the wave-lengths of all the lines which the atom is capable of absorbing may be computed. In this way many faint lines which do not appear at all in emission have been identified among the faint solar lines. In the spectra of krypton and xenon precision wave-lengths have been determined by interference methods, thus adding to the list of standards for reference spectra.

Last year mention was made of the observations on the ultra-violet component of sunlight, which the Bureau had conducted at Flagstaff, Arizona. During the past year this work has been continued at a sea-level station (Washington, D. C.). Particular attention has been paid to the development of instruments for measuring the ultra-violet component of sunlight, and several improvements in their design have been carried out.

A free pendulum has been built by the time section of the Bureau and is being used in certain research work. Signals are taken from the pendulum by means of a photo-electric cell. The pendulum itself is kept in motion by an electromagnetic impulse operated from the signals from the photo-electric cell. A relay permits transmission to various laboratories. A case is now being built for the pendulum. This case will be mounted on a concrete pier and maintained at constant temperature and pressure. The signals obtained from the pendulum are expected to be of very high accuracy.

A primary radio-frequency standard, consisting of four special piezo oscillators of great accuracy, was purchased by the Bureau several months ago. Auxiliary equipment was constructed in the Bureau's shops, and the standard has been in successful operation for some time. Care is taken to maintain this equipment under uniform conditions in order that the frequency may remain constant to the high order desired, which is a variation of only one part in several millions. Currents are furnished by this standard at 100,000, 10,000, 1,000, 100, and 10 cycles per second, and seconds impulses are given. These accurately known frequencies can be made available for measurement purposes in most of the Bureau's buildings. The frequencies of the four piezo oscillators have been found to increase at the rate of about one part in a million per month.

An automatic radio-fading recorder was operated, chiefly during the day, for several months at the Bureau's field station in Kensington, Maryland. These records have been used in a study of the relation between radio reception and geophysical phenomena. Magnetic storms have not affected the received intensity, but atmospherics have been increased. The eclipse of April 28, 1930, did not affect the records.

Oscillographic records were also made at Kensington on pulse signals from Station NKF (U. S. Navy, Bellevue, D. C.) using frequencies of 4045 and 8650 kc. The virtual height of the Kennelly-Heaviside layer was from 225 to 250 km on the former frequency and about 290 km on the latter. A 100-km layer was also observed on the lower frequency. The height of the layer changes during the day and is affected by magnetic storms.

The Bureau's letter circular 32 (mimeographed) on methods of silvering glass has had a wide circulation and has been revised several times since it was first issued in 1919. A new printed circular on this subject will soon be ready. In connection with its preparation considerable work has been done in refining and improving the technique and in simplifying the formulas so as to make success in their use more certain and less dependent upon previous experience. The circular will give methods for the chemical deposition of silver, copper, platinum, and lead sulphide, and for the production of mirrors by cathode sputtering and by the condensation of metallic vapors on glass.

G. K. Burgess, *Director.*

UNIVERSITY OF CALIFORNIA

Berkeley Astronomical Department

Students' Observatory

Mr. Meyer exchanged with Mr. Trumpler of the Lick Observatory during the second half-year. At the close of the year Mr. Meyer was promoted from Associate Professor of Astrophysics to Professor of Astronomy. At the Lick Observatory Mr. Meyer took part in the regular spectroscopic observing program with the 36-inch refractor and secured and measured 23 photographic positions of the newly announced Lowell Observatory object "Pluto." These positions proved of great importance for the determination of the orbit of Pluto. He also secured observations of comets 1930 *d* (Schwassmann-Wachmann) and 1930 *c* (Wilk) and secured and measured 23 spectrograms of Beta Canis Majoris for radial velocities. On April 28 Messrs. Meyer and Shane took part in the observation of the total solar eclipse at Camptonville, California, as members of the Lick Observatory-Crocker Eclipse Expedition.

The unusually large number of 20 resident graduate students and astronomers from other institutions engaged in research, as well as the growth of the R.O.T.C. Naval Unit, for which instruction in Navigation and Nautical Astronomy is given under the auspices of the Department, with Professor Einarsson and naval officers in charge, necessitated the erection of an additional building with four offices, two class rooms, and a spectroscopic laboratory. The principal instrument to be installed in the latter will be a horizontal Littrow spectrograph.

The Naval R.O.T.C. was inaugurated in 1926 with the first contingent of 60 students enrolled. Of these, 20 have received commissions on

graduation with the bachelor's degree in May, 1930, or soon after. One of the features of the instruction is that students other than those enrolled in the Naval Unit are admitted to the four-year series courses. Many of these non-naval students are studying the subject scientifically as an aid to their later business and professional careers and to enable them to handle their own pleasure craft. The growth of the instruction is exhibited in the following table of enrollments:

Year	Navy	Elective	Total
1926-1927	58	29	87
1927-1928	113	60	173
1928-1929	138	89	227
1929-1930	189	93	282

The difference of 51 in the Navy enrollments for 1929-30 from 240, the number for which provision was made, represents the number who left the University or the Naval Unit.

During the year Mr. Crawford's volume on the determination of orbits of comets and asteroids was published by the McGraw-Hill Book Company.

Study of the preliminary data secured by Mr. Shane at the Mount Wilson Observatory during the summer of 1929 in connection with his development of a new method of determining the contours of lines in the solar spectrum suggested certain changes in technique which he applied to observations at Mount Wilson during the summer of 1930.

As heretofore, orbits of new comets and of some minor planets have been derived. Of chief interest, however, is the comprehensive investigation of the orbit of Pluto by Bower and Whipple. Preliminary results based on an arc of 17 days indicated the possibility of orbits ranging from a near circle to a parabola, with well-determined distance, inclination, and node. A quite definite determination of the orbit was made possible by later observations in 1930, chiefly by Meyer at the Lick Observatory and by the identification of the object on prediscovery plates: in order of announcement, at Uccle by Delporte January, 1927, at Mount Wilson by Nicholson on four plates taken by Humason December, 1919, and at Williams Bay by Ross on plates taken by him January, 1927, and by Barnard January, 1921.

Mention should be made also of the computation of orbits and ephemerides of Comet 1929 *d* (Wilk) by Bower and Whipple; Comet 1929 *b* (Neujmin) by Bower and Willis; Comet 1930 *b* (Beyer) by Bower and Miss Moore; Comet 1930 *a* (Peltier-Schwassmann-Wachmann) by Bower and Whipple; Comet 1930 *c* (Wilk) by Whipple and Miss Hayford; Minor Planet Y.O. 2 (1922 NC) by Miss Moore and Miss Hayford; Comet 1930 *d* (Schwassmann-Wachmann) by Miss Hayford and Anderson.

In most of these orbit determinations errors of observations, which are certainly avoidable, have been responsible for much waste of time and effort on the part of the computers.

Further revision has been made of the Research Surveys of the

Minor Planets. In view of the satisfactory representation of observations, tables of the perturbations by Jupiter of twelve minor planets discovered by James C. Watson have been extended by Thiele from the year 1930 to 2020.

During the year Mr. N. U. Mayall has been attached to the staff of the Mount Wilson Observatory as Assistant. Mr. J. Ueta, Assistant Professor of Astronomy at Kyoto Imperial University, continued his residence at Berkeley until the end of the academic year, chiefly engaged in testing the applicability of our orbit methods and studying, by means of perturbations, the possible relationship of Comet 1929 *a* (Schwassmann-Wachmann) and Minor Planet 525 Adelaide. The elements of the two objects are practically identical with the exception of the argument of perihelion.

Mrs. M. W. Makemson, Miss L. T. Slocum, and Mr. J. A. Pearce have completed their work for the degree of Doctor of Philosophy. The subjects of the theses were: Mrs. Makemson, "The Orbit of Comet 1927 *f* (Gale) with Special Reference to the Question of Double Solutions"; Miss Slocum, "A Study of Color Indices of Faint Stars in Five Selected Areas in the Milky Way"; Mr. Pearce, "Motions of the O and B Type Stars." Mr. Pearce continues in his position as Astronomer at the Dominion Astrophysical Observatory, Victoria, B. C. Miss Slocum has received an appointment at Whitin Observatory, Wellesley College, as Assistant Professor, and Mrs. Makemson as Instructor in the Berkeley Astronomical Department. Miss Barbara Pease, who received the M.A. degree on a thesis entitled "Investigation of Constants of the new Gaertner Prismatic Transit Instrument at the Students' Observatory," has been appointed Instructor at the Whitin Observatory.

The following have been in residence at Berkeley on fellowships during the academic year 1929-30: N. T. Bobrovnikoff, National Research Council Fellow; E. C. Bower, Martin Kellogg Fellow; H. B. Kaster, Morrison Fellow; Mrs. M. W. Makemson, Morrison Fellow; Miss Charlotte E. Moore and F. L. Whipple, Lick Fellows. The third Lick Fellow, R. S. Richardson, was in residence at Mount Hamilton. Teaching fellowships at Berkeley were held by Miss Phyllis Hayford, Clifford Smith, H. C. Willis, S. L. Thorndike, and C. M. Anderson in connection with their graduate studies.

The weekly departmental seminar, in which a wide variety of subjects is discussed, is an important feature in the scientific training of graduate students.

A. O. Leuschner, *Director.*

OBSERVATORIO NACIONAL ARGENTINO

Córdoba, Argentina

(For the year 1929)

Due to the work of completing the new administration building no observations were attempted beyond those necessary to control the clocks.

The building was essentially completed during the year, only lacking

connection with the light and power mains to be fully occupied.

The current supply as well as the telegraph line to the central government telegraph office is being changed within the observatory grounds to underground cables.

The installation of the 75-centimeter reflector, 13-centimeter DM refractor, and portrait-lens telescopes was begun. These telescopes occupy three new domes of the new building.

The work on the 60-inch reflector in the Sierras was resumed. The walls for the domes are over half up.

The fundamental catalogue of 761 stars was completed and printed.

The polar catalogue is essentially reduced to epoch and ready for precessions.

Good progress was made in the reductions of the observations for the last zone of the DM, —62° to —82°, but, owing to the high declinations, the work has progressed more slowly than was expected. It is hoped, however, to complete it in 1930.

The DM maps from —42° to the pole are completed and the distribution only awaits the receipt of those made in London.

Considerable time was spent on the determinations of the brightness of Halley's comet from photographs, with a photo-electric cell. The results, however, are not yet entirely satisfactory.

The stars to be observed for the A.G. zone —37° to —52° were selected.

The usual public services, with the exception of visitors, were maintained.

C. D. PERRINE, *Director.*

DEARBORN OBSERVATORY

NORTHWESTERN UNIVERSITY

EVANSTON, ILLINOIS

Much of the writer's time has been spent in a study of the astrometric properties of the field of the 18½-inch refractor for field parallaxes. The equatorial zone of Kapteyn's Selected Areas was undertaken by this observatory many years ago, and half a dozen good plates, more or less, for each of the twenty-four areas had been taken. Many more have now been taken. It is intended to use twenty to thirty exposures for each area. Plates are exposed for one hour.

Mr. Newton L. Pierce has used the stellar spectrograph to study a few bright spectrographic binaries of early type. Alpha Cygni has received especial attention.

The observatory agreed to take a part in the Eros campaign in 1930 and 1931.

OLIVER J. LEE, *Director.*

DOMINION OBSERVATORY

OTTAWA, CANADA

Meridian Work and Time Service. With the meridian circle there were obtained during the year 3168 observations for right ascension

and declination of stars, the sun, moon, and planets. A Synchronome free pendulum clock was added to the primary clocks in the new clock vault. The synchronized time service maintained throughout the government buildings has expanded steadily. Time was distributed by clock beats over the telephone, by telegraph line at noon, by broadcast through radio station CNRO at 3:00 P.M., and by short-wave broadcast from the Observatory at the same hour. Time signals from Annapolis, Bordeaux, Nauen, and Rugby were received regularly by coincidence methods, and frequently by automatic registration.

Solar Physics. Some 215 spectrum observations of centre, midway, and limb points on the sun with iodine absorption at λ 5600 were secured, and a like number of measurements and computations made. Direct photographs of the sun to the number of 144 were taken. Steps were taken to secure tree sections from various parts of Canada to study the sunspot influence and any changes of phase. A striking relationship to sunspots was found in the Criddle records at Aweme, Manitoba, from 1895 to 1929, for grasshoppers, ruffed grouse, sharp-tailed grouse, and varying hares, all being plentiful at the minima or shortly after and scarce at and after maxima of spots.

Fifteen-inch Equatorial. The telescope was employed chiefly in the further study of spectroscopic binaries, with special reference to suspected triple systems. Among the systems studied η Virginis proved of particular interest, the orbit exhibiting considerable variations of period and of eccentricity. The analysis of spectrograms of Cepheid variables was continued, the Cepheids χ Ursae Minoris and RT Aurigae having been studied in collaboration with McGill University. An investigation by Dr. A. V. Douglas of McGill showed cyanogen absorption in the telescope and spectrograph to be practically negligible. A Moll microphotometer of the latest type was obtained during the year for use in spectrum analysis.

Photographic Photometry. Observations were begun on the new international Cepheid program. Fifty-three of the variable fields were photographed with the 8-inch camera; charts of these were prepared and forwarded to Harvard for distribution to coöperating observatories after selection and marking of comparison stars. Plates to the number of about 300 were also made of the variable fields with the smaller cameras for the purpose of determining the light curves.

Seismology. During the year four hundred and two earthquakes were recorded. Those of sufficient importance were reported to the press and by telegraph to Science Service, Washington. Monthly bulletins were distributed to 237 stations. The seismographs at Ottawa, Saskatoon, Halifax, Shawinigan Falls, and Seven Falls were in practically continuous operation. Four issues of the *Bibliography of Seismology* were prepared during the year. A preliminary report on the Grand Banks Earthquake of November 18, 1929, was presented at the Washington Meeting of the Eastern Section of the Seismological So-

ciety of America; a detailed study is in progress. An investigation of surface waves generated by distant earthquakes was completed and will be issued shortly.

Terrestrial Magnetism. Observations of the magnetic elements, declination, inclination, and horizontal intensity, were made at 10 stations along the water route between Sioux Lookout and James bay by way of lac Seul, Root, and Albany rivers. Of these, three are exact and three approximate re-occupations of stations established by the Carnegie Institution in 1913, while three of the remaining four are new. In addition, magnetic observations were made in conjunction with gravitational surveys which were carried out with the torsion balance in the vicinity of two known faults near Ottawa.

Gravity. In connection with the transatlantic gravity comparisons a determination of the temperature coefficients of the standard pendulums was made. In June, 1930, work was resumed on a field program involving the determination of gravity at various stations in Eastern Canada. Isostatic computations were made for the effects produced by distant zones at a number of points throughout the country. As a result of these computations it will be possible to obtain by simple interpolation the effects produced by distant topography for any stations that are likely to be established during the next few years. In coöperation with the Geological Survey of Canada, torsion balance surveys were made of two well-known faults in the vicinity of Ottawa. Surveys of certain geological structures and mineral deposits in the province of Quebec were made with magnetic variometers.

R. Meldrum Stewart, *Director.*

DOMINION ASTROPHYSICAL OBSERVATORY

Victoria, British Columbia

(For the year ending March 31, 1930)

Staff. The regular staff remains the same as given in the last report. During six months of the summer of 1929 Professor A. Pannekoek of the University of Amsterdam was engaged in securing three-prism spectra of a selected list of stars with a view to theoretical studies in the intensities of absorption lines and ionization in stellar atmospheres.

Observing. As in previous years, the whole time of the telescope, except two hours for visitors every Saturday evening, was devoted to photographing stellar spectra. The observing weather was considerably above the average even exceeding that of last year. The eleven-year average shows that on 207 nights with a total exposure time of 1259.4 hours there were secured 1558 plates. While the number of plates secured the past year, 1133, is considerably smaller than the average, this is a necessary consequence of the investigations being carried to increasingly fainter stars which require longer exposures. A better index is the total observing time and on 223 nights in the past year a total of 1497.1 hours was secured which is about 19 per cent above the average.

Programs and Results. The investigation of all B-type stars brighter than 7.50 and north of declination —11° which has been in progress since 1924 was completed during the year. This program involves the observation and measurement of 3500 observations of 550 stars. Following the completion of the manuscript for publication a general catalogue was compiled. This catalogue contains 1560 entries for 996 stars. 458 of the stellar velocities (46%) were determined solely at this institution, these being for stars fainter than 5.50.

Preliminary solutions for the K term and galactic rotation for the O- and B-type stars were made. It was found that the K term vanishes for stars fainter than the 6th magnitude. It seems likely that this hitherto unexplained term in radial velocity is caused by group motion of recession of the bright stars (brighter than 5.50) in the southern hemisphere. The nearest group of stars B3-B5 brighter than 5.50 does not show a galactic rotation but the other more distant groups show a decided rotation about a distant centre in galactic longitude 326° in the direction of the constellation of Sagittarius. This research confirms the hypothesis of Lindblad and Oort.

The motions and distribution of the interstellar matter were determined from the observations of the interstellar lines H and K in the spectra of 261 O and B2 stars. The determination of the sun's velocity and apex for the interstellar matter gave values in good agreement with the elements determined by Campbell for 2149 naked-eye stars. The calcium cloud had no K term. The solutions for galactic rotation show conclusively that this diffuse interstellar matter is in rotation about the same distant centre in galactic longitude 332° $\pm$ 6°. Further, by solving concurrently for the distances of the interstellar matter and the stars in whose spectra the lines are observed, it was shown that the interstellar matter is uniformly distributed throughout space. The rotational coefficient for the stars has exactly twice the value of that for the clouds, thus confirming Eddington's hypothesis of uniform distribution.

Further solutions of the motions of the O- and B-type stars are now being made to deduce final values for the solar motion, K term, and galactic rotation.

About 450 spectra were secured during the year on the A-type program including spectra of possibly 100 stars which we had not previously secured. The remainder were additional plates for other stars. Slightly over 500 were measured during the year for radial velocity, a few having to do with spectroscopic binaries. We have now the spectra of about 1100 A-type stars to be used later for spectroscopic parallax work.

The orbits of two A-type stars, Boss 613 and H.R. 3352, were completed during the year but not published. A revision of the elements of the binary 19 Draconis was made as recent observations suggested a slight correction to the period formerly adopted. A number of spectrograms of the B-type binary star H.D. 185936 were remeasured and a satisfactory period in the neighborhood of 2.5 days deduced.

Observations of the eclipsing variable Y Cygni have been continued. Calculations of the orbital elements for the years 1919-21 and for 1928-29 show clearly the rotation of periastron detected by other methods. Further, the quantitative agreement with the latest photometric results by Professor R. S. Dugan, Princeton, is good, in view of the uncertainty of the observation. A marked change has been found in the velocity of the system, indicating the presence of a third body with a spectrum too faint to be observed.

Measurements have been made of the radial velocities of 209 faint K stars near the galactic equator and 15 near the galactic pole. An analysis of the velocities has given the solar motion and galactic rotation effect for these stars. The results agree with those derived by other astronomers from proper motion data. It is found that the peculiar velocities of these K stars are high (four have been observed greater than 100 km/sec) and they show definite signs of stream motion. Observations are being continued in order to place these conclusions on a firmer basis.

A spectroscopic study of two semi-regular variables, SV Ursae Majoris and V Ursae Minoris, has been commenced.

The program of observation of Wolf-Rayet stars, begun in the fall of 1927, was completed this year. Analysis of the complete data has made it possible to formulate a theory concerning the physical nature of these peculiar objects. This theory attributes the broad band emission spectra of Wolf-Rayet stars to the continuous ejection of gaseous material from the stellar surface by selective radiation pressure. A new system of classification has been devised for the Wolf-Rayet stars which defines their position relative to other stars in the Harvard sequence.

An investigation of the physical nature of the variable star Z Ursae Majoris was begun and some 22 spectrograms of the star were obtained during the year.

New Equipment. A 10-foot grating spectrograph of Littrow form was completed and installed in the laboratory. This instrument has been used for the photometric determination of line intensities in laboratory spectra.

Visitors. Many noted astronomers from all over the world visit the observatory from time to time. Including day visitors, approximately 39,000 persons visited the institution the past year.

J. S. PLASKETT, *Director.*

(To be continued.)

PLANET NOTES FOR MARCH, 1931

By CLIFFORD E. SMITH.

The *Sun* will be moving northeast from the central part of Aquarius to the central part of Pisces. On March 21 at 8:00 A.M., C.S.T., the sun will be at the vernal equinox, and this event marks the official beginning of spring. Its position on the first and last days of the month will be, respectively: R.A. $22^h\,44^m$, Decl. $-8°\ 2'$; and R.A. $0^h\,34^m$, Decl. $+3°\ 42'$.

The phases of the *Moon* will occur as follows:

Full Moon	March	4 at	5 A.M.	C.S.T.
Last Quarter		10 "	11 P.M.	"
New Moon		19 "	2 A.M.	"
First Quarter		26 "	11 P.M.	"

Perigee will occur at 5:00 A.M., C.S.T., March 4, and apogee at 5:00 P.M., C.S.T., March 17.

Mercury will be moving with an apparent easterly motion from the central part of Aquarius to the eastern part of Pisces. Early in the month it will be a morning star of brightness about minus one, rising about forty minutes before the sun. Superior conjunction will occur on March 16 and thus by the end of the month it will be an evening star setting about fifty minutes after the sun. Conjunction with the moon will occur on March 19, and conjunction with Uranus will occur on March 26. Mercuy will be at perihelion on March 30.

Venus will be moving from eastern Sagittarius to eastern Capricornus. It will continue as a morning star of brightness about minus three, rising about three hours before the sun. Conjunction with the moon will occur on March 15.

Mars will be an evening star in western Cancer of brightness about magnitude zero. Its apparent motion among the stars will be westerly until March 9, and the remainder of the month easterly. At the middle of the month it will be on the meridian about 8:30 P.M. Conjunction with the moon will occur on March 1 and again on March 28.

Jupiter will continue as an evening star of brightness about magnitude minus two in western Gemini. Its apparent motion among the stars will be retrograde until March 7, and thereafter direct. During the middle of the month Jupiter will be on the meridian about 7:00 P.M. Conjunction with the moon will occur on March 27.

Saturn will be a morning star in eastern Sagittarius of brightness about magnitude plus one. During the middle of the month it will rise about four hours before the sun. Conjunction with the moon will occur on March 13.

Uranus will be near the sun in apparent position during this period, conjunction with the sun occurring early in April.

Neptune will be in central Leo, and during the middle of the month it will be on the meridian about 11:00 P.M. Its apparent motion will be retrograde and it will be in conjunction with the moon on March 3.

Eros Ephemeris.—The ephemeris of Eros is given here for four-day intervals during February. These positions are taken from a paper by G. Witt in *A.N.*, No. 5760. Before the end of the month this asteroid will be too far south

for observations from northern stations, but our readers south of the equator may still find the ephemeris useful.

1931 0^h U.T.	α (1930.0) h m s	δ (1930.0) ° ′ ″	Log. Δ	Log. r	M
Feb. 0	10 20 47.93	— 3 41 51.8	9.24089	0.05619	7.1
4	15 44.76	7 52 58.0	.24431	.05743	7.1
8	10 5.14	11 43 52.5	.25230	.05896	7.2
12	10 4 3.94	15 9 1.6	.26438	.06077	7.2
16	9 57 58.79	18 4 59.8	.27996	.06285	7.3
20	52 8.27	20 30 40.0	.29834	.06518	7.4
24	46 49.50	22 26 55.9	.31888	.06775	7.6
28	9 42 16.27	—23 56 6.0	9.34096	0.07054	7.7

Occultations

VISIBLE AT WASHINGTON.

[From the *American Ephemeris.*]

Date 1931	Star	Mag.	IMMERSION Washington C.T. h m	IMMERSION a m	IMMERSION b m	IMMERSION Angle E from N °	EMERSION Washington C.T. h m	EMERSION a m	EMERSION b m	EMERSION Angle E from N °
Mar. 1	4 Cnc	6.2	4 8	—0.1	—0.5	61	4 41	+0.9	—1.8	335
3	*l* Leo	5.2	21 27	—1.3	—0.2	120	22 38	—1.4	—0.8	309
5	β Vir	3.8	2 25	..	..	204	2 44	..	..	237
24	χ Tau	5.3	20 40	—0.9	—0.5	68	21 43	—0.1	—1.7	282
31	σ Leo	4.2	23 48	—1.1	—1.6	136	0 58	—1.2	—1.6	303

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 or 300 miles of Washington. The procedure is as follows: Subtract the longitude of Washington (77°.1) from the longitude of the place in question; multiply the result, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude (38°.9) using *b*; apply the sum of the products, with its proper sign, to the Washington C.T., and obtain the predicted Washington Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to add 8.3 minutes to Washington Civil Time.

VISIBLE AT LICK OBSERVATORY AND VICINITY.

Date 1931	Star	Mag.	G.C.T. h m	a m	b m	P °
March 1	ω Cancri	6.1	8 35	—1.3	+1.1	85
1	4 Cancri	6.2	9 08	—0.4	—0.4	129
4	*l* Leonis	5.2	2 05	—0.2	—1.7	130
25	χ Tauri	5.3	0 34	—2.3	+0.5	83
26	354 B. Tauri	6.4	1 11	—2.1	+1.6	56
27	49 Aurigae	5.1	8 10	—0.3	+1.6	72
29	28 Cancri	6.1	2 59	—2.1	—0.6	92

VISIBLE AT OMAHA AND VICINITY.

Date 1931	Star	Mag.	G.C.T. h m	a m	b m	P °
March 1	4 Cancri	6.2	9 11	—0.3	+1.4	83
4	*l* Leonis	5.2	2 16	—0.7	—1.1	121
25	χ Tauri	5.3	0 31	—1.5	+1.7	75
26	354 B. Tauri	6.4	1 14	Grazing		28

The approximate times for observers within 300 miles of Omaha can be found by using the constants *a* and *b*, given in the table, according to the formula

$$\text{G.C.T.} = \text{Predicted G.C.T.} + a\Delta\lambda + b\Delta\phi,$$

$\Delta\lambda$ and $\Delta\phi$ in this case being obtained by using the longitude (96°0) and latitude (41°3) of Omaha, and subtracting these, respectively, from the longitude and latitude of the place.

For observers within 300 miles of Mount Hamilton, California, the same rule is followed using the longitude (121°7) and latitude (37°3) of Lick Observatory.

Only disappearances are given.

WM. CLETUS DOYLE, S.J.

Creighton University Observatory.

Ephemeris of Pluto.—I am sending you an ephemeris of Pluto for the three months February, March, April, 1931. The computation is based upon elements by Dr. A. C. D. Crommelin, published in *B.A.A. Circular*, No. 93, dated May 19, 1930. How slowly the planet moves! $\mu = 13''.3751$. From February 1 to April 30, 1931, it will move over a heliocentric arc of 1085″, a distance the Earth will move over in seven and one-quarter hours. According to Dr. Crommelin, Pluto will not reach perihelion until December 5, 1984, a long time ahead.

EPHEMERIS.

1931 U.T.		α h m s	δ ° ′ ″	Log. r	Log. Δ
February	1.0	7 23 50	+22 12 25	1.614777	1.605006
	9.0	7 23 12	22 14 11	1.614712	1.605583
	17.0	7 22 37	22 15 50	1.614647	1.606343
	25.0	7 22 7	22 17 19	1.614582	1.607266
March	5.0	7 21 41	22 18 38	1.614517	1.608231
	13.0	7 21 22	22 19 45	1.614452	1.609513
	21.0	7 21 9	22 20 39	1.614386	1.610786
	29.0	7 21 2	22 21 20	1.614321	1.612122
April	6.0	7 21 3	22 21 48	1.614256	1.613493
	14.0	7 21 9	22 22 3	1.614191	1.614872
	22.0	7 21 23	22 22 4	1.614126	1.616232
	30.0	7 21 43	+22 21 53	1.614060	1.617546

FRANK E. SEAGRAVE.

Boston, Massachusetts, January 3, 1931.

VARIABLE STARS

Monthly Report of the American Association of Variable Star Observers for December, 1930

At a recent meeting of the Council held at New Haven, Connecticut, the following were duly elected to membership in the Association:

Wm. Brackett Stearns	Milton, Massachusetts
Franklin B. Wright	Berkeley, California
H. Page Bailey	Riverside, California
Jack Percival	St. Louis, Missouri
R. C. Shinkfield	Adelaide, South Australia
Walter Theile	Marburg, Germany
E. Clinton Jansen	Denver, Colorado

Messrs. Wright and Shinkfield have already contributed a report or two to these columns.

At this same meeting it was also voted that the Association would issue the

Variable Star Observations Received During December, 1930.

Oct. 0 = J.D. 2426250; Nov. 0 = J.D. 2426281; Dec. 0 = J.D. 2426311.

J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
V Scl	R And	U Cas	U And	U Per	o Cet
000339	001838	004047	010940	015254	*021403*
183 11.8 Dr	320 7.0 Ma	289 13.1 L	289[13.5 L	298 8.0 Pt	299 8.9 Ah
232 13.8 Dr	321 7.2 GD	298 12.0 Pt	301 13.3 Mg	301 8.5 BL	301 8.7 Gy
236 14.3 Dr	326 6.9 Ma	309 10.8 Bw	UZ And	309 8.1 BL	302 9.0 BL
267[13.3 Bl	S Tuc	310 11.0 Br	011041	309 8.4 Bw	302 8.5 Tf
301[13.6 Dr	*001862*	311 10.7 Lg	303 11.2 Ma	313 8.0 BL	303 9.1 Ma
S Scl	236 10.9 Dr	323 10.0 Sf	303 11.2 Bw	320 8.2 BL	304 8.9 Wd
001032	263 10.2 Ht	RW And	320 11.1 Ma	321 8.4 BL	306 9.0 Ah
183 9.9 Dr	265 10.2 En	004132	326 11.1 Ma	S Ari	313 9.2 BL
232 8.0 Dr	268 10.1 Ht	289 9.5 L	S Psc	015912	319 9.0 Wd
236 7.7 Dr	277 10.2 Ht	297 9.6 Tf	011208	293 14.7 L	320 9.5 BL
263 6.8 Ht	297 10.5 Dr	298 9.8 Pt	293 13.7 L	306[14.0 B	321 9.4 BL
265 6.3 En	313 11.4 Dr	302 9.8 Tf	S Cas	P Ari	S Per
268 6.7 Ht	S Cet	310 9.3 Br	011272	021024	021558
277 6.7 Ht	*001909*	311 8.7 Lg	296 12.8 B	293 10.2 L	295 9.3 Ah
277 6.7 En	292 7.8 L	V And	U Psc	295 10.5 Ah	298 9.0 Me
297 6.8 Dr	292 7.9 Tf	004435	011712	295 10.5 Fd	298 9.2 Pt
298 6.9 Pt	297 8.3 Tf	310 11.2 Br	293 12.4 L	298 10.6 Pt	300 10.0 Sz
313 7.3 Dr	298 8.0 Pt	311 11.3 Lg	298 12.5 Pt	299 10.5 Ah	302 9.5 BL
X And	300 8.0 Sf	RR And	301 13.0 Mg	300 10.3 Fd	303 9.4 BL
001046	302 7.8 Tf	004533	R Scl	303 10.3 Fd	306 8.6 Al
303[13.4 Bw	320 8.0 Sf	301 12.9 Mg	*012233a*	303 10.3 Ma	306 9.3 B
311[13.5 Lg	326 8.3 Fe	310 12.0 Br	183 7.2 Dr	306 10.0 B	308 9.4 Ah
T Cet	T Scl	311 12.8 Lg	236 7.3 Dr	306 10.2 Ah	309 9.4 BL
001620	*002438a*	— Cas	RZ Per	320 9.7 Fd	313 9.3 BL
292 5.7 L	183 9.7 Dr	004746b	012350	320 9.6 Ma	320 9.2 BL
292 5.7 Tf	232 9.1 Dr	298 10.4 Pt	288 9.6 L	326 9.2 Ma	321 9.2 BL
297 5.6 Tf	236 9.2 Dr	W Cas	306 9.8 Al	W And	324 9.3 BL
302 5.6 Tf	267 12.0 En	004958	R Psc	021143a	R Cet
T And	297 13.3 Dr	298 9.0 Pt	012502	298 13.4 Pt	*022000*
001726	RR Scl	301 9.9 BL	290 9.6 Ah	306 13.1 B	293 13.1 L
298 13.5 Pt	*002438b*	303 9.8 BL	295 9.3 Ah	T Per	326 8.4 Fe
311 12.4 Lg	183 12.7 Dr	303 10.3 Bw	298 9.2 Pt	021258	RR Per
T Cas	232 12.6 Dr	309 9.7 BL	299 9.6 Ah	295 8.6 Ah	022150
001755	297 13.0 Dr	313 9.7 BL	306 9.3 Ah	298 8.6 Me	287 10.3 L
290 8.8 Ah	T Phe	315 9.7 BL	320 10.0 BE	298 8.2 Pt	298 10.3 Pt
293 8.3 L	*002546*	320 9.6 BL	RU And	302 8.4 BL	U Cet
295 9.2 Ah	183 12.3 Dr	321 9.7 BL	013238	303 8.5 BL	*022813*
298 8.2 Pt	232 14.0 Dr	322 9.6 BL	287 11.4 L	308 8.7 Ah	298 11.2 Pt
299 9.0 Ah	236 14.0 Dr	U Tuc	298 11.1 Pt	309 8.7 BL	301 11.7 Gy
303 8.3 Al	265[13.0 En	*005475*	301 11.9 Mg	313 8.8 BL	302 10.9 BL
306 8.8 Ah	277[13.0 Ht	183 8.8 Dr	303 11.2 Ma	321 9.0 BL	RR Cep
308 8.9 Ah	297 15.0 Dr	232 11.5 Dr	306 11.2 Al	324 9.1 BL	022980
310 8.8 Ah	W Scl	236 11.7 Dr	320 11.2 BE	Z Cep	289 13.5 L
R And	*002833*	263 13.2 Ht	320 10.7 Ma	021281	R Tri
001838	183 13.4 Dr	267 12.9 En	326 11.0 Ma	287 12.0 L	023133
290 8.6 Ah	236 13.3 Dr	268 13.3 Ht	Y And	298 12.0 Pt	290 7.1 Ah
295 8.3 Ah	267[12.8 En	277 13.2 Ht	013338	o Cet	291 7.5 Tf
295 8.0 Fd	301 13.4 Dr	297 13.8 Dr	287 11.1 L	*021403*	295 7.3 Ah
297 8.4 Me	Y Cep	Z Cet	298 10.6 Pt	263 7.2 Sl	298 7.3 Pt
298 8.0 Pt	003179	*010102*	301 10.3 Mg	274 7.5 Sl	298 7.5 Tf
299 8.3 Ah	293 14.2 L	293 10.1 L	303 10.1 Ma	278 8.0 En	299 7.4 Ah
301 7.9 Gy	310[13.2 Br	298 9.8 Pt	320 10.1 Ma	281 7.8 Sl	300 7.3 Fd
303 8.2 Wd	α Cas	U Scl	326 10.5 Ma	290 8.6 Ah	300 7.5 Sf
303 7.9 Ma	003656	*010630*	X Cas	293 8.4 L	301 7.6 Gy
306 8.1 Ah	327 2.3 Mc	183 13.4 Dr	014958	295 8.8 Ah	302 7.5 Tf
307 7.9 Ah		268[13.2 En	298 11.3 Pt	298 8.6 Tf	303 7.4 Ma
310 7.8 Ah		297[13.5 Dr		298 8.5 Pt	304 7.9 Wd

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R TRI	Y PER	T CAM	V TAU	T COL	RR TAU
023133	032043	043065	044617	*051533*	053326
304 7.8 Sf	298 8.6 Pt	313 10.4 BL	298 9.5 Pt	*277* 11.9 Ht	*288* 10.6 L
306 8.0 Ah	299 8.9 Ah	321 11.2 BL	R ORI	*297* 10.2 Dr	290 10.5 L
308 8.2 Ah	302 8.1 BL	RX TAU	045307	313 9.7 Dr	291 10.7 L
311 8.4 Tf	303 8.2 BL	043208	*288* 9.6 L	S AUR	*293* 11.0 L
319 9.0 Sf	307 8.5 Ah	*289* 11.6 L	301 9.7 Mg	052034	294 11.1 L
320 9.0 Fd	309 8.0 BL	298 12.5 Pt	R LEP	298 8.4 Pt	295 11.2 L
320 9.0 Ma	313 8.0 BL	306 12.5 B	*045514*	300 9.9 Fd	296 11.7 L
323 9.1 Sf	321 8.0 BL	*327* 13.0 Gc	*275* 6.4 Sl	320 9.7 Fd	297 11.0 L
326 8.7 Ma	R PER	R RET	*288* 6.2 L	*327* 9.8 Mc	300 11.2 L
T ARI	032335	*043263*	*292* 6.4 Tf	W AUR	303 10.9 L
024217	289 12.1 L	183 12.3 Dr	298 5.7 Tf	052036	304 10.8 L
298 8.3 Me	298 12.8 Pt	236 13.5 Dr	298 6.5 Pt	293 13.7 L	306 11.1 B
W PER	301 13.3 Mg	263[12.3 Ht	303 5.7 Tf	303 13.6 Ma	RV AUR
024356	303 13.7 Ma	267[12.2 En	303 6.1 Ma	S ORI	053337
298 8.8 Me	306 13.3 B	274 13.4 Sl	*326* 5.9 Ma	*052404*	298 11.5 Pt
298 8.5 Pt	T FOR	281 13.0 Sl	V ORI	298 10.4 Pt	320[12.1 Fd
300 9.0 Fd	*032528*	*297* 12.1 Dr	050003	303 11.0 Ma	U AUR
307 8.5 Bg	293 9.3 L	313 10.9 Dr	288 9.5 L	*326* 10.7 Ma	053531
312 9.0 Bw	U ERI	X CAM	295 10.0 Ah	T ORI	293 13.3 L
313 8.5 Bg	*034625*	043274	298 9.8 Pt	*053005a*	298 12.9 Pt
324 8.6 Bg	183 11.8 Dr	*286* 9.5 L	301 9.7 Mg	286 10.3 L	SU TAU
R HOR	293 13.4 L	295 10.0 L	306 10.0 Ah	287 11.4 L	054319
025050	T ERI	298 10.4 Pt	T LEP	288 11.8 L	286[13.8 L
183 8.6 Dr	*035124*	R DOR	*050022*	289 11.5 L	291[13.3 L
236 10.8 Dr	183 7.3 Dr	*043562*	*298* 10.5 Pt	290 10.8 L	293[14.6 L
263 12.5 Ht	*236* 9.5 Dr	183 5.1 Dr	S PIC	291 10.3 L	294[15.0 L
267 12.4 En	W ERI	236 4.8 Dr	*050848*	*293* 10.3 L	295[12.1 Pt
268 12.6 Ht	*040725*	*263* 5.2 Ht	236 13.3 Dr	294 10.8 L	296 15.0 L
274 12.0 Sl	183 12.4 Dr	*267* 5.5 En	263 12.7 Ht	294 10.5 Pt	298[13.0 Pt
277 12.4 Ht	236 13.0 Dr	*268* 5.1 Ht	268 12.6 Ht	295 10.6 Pt	299[13.7 B
280 12.4 Sl	313 12.5 Dr	*274* 5.3 En	274 11.8 En	295 10.7 L	301[12.1 Pt
297 12.6 Dr	R TAU	*274* 5.3 Sl	277 11.7 En	296 10.8 L	302[13.1 Pt
T HOR	042209	277 5.4 Ht	277 11.6 Ht	296 10.5 Pt	303[15.2 L
025751	202 12.2 Ma	313 5.1 Dr	297 9.6 Dr	297 11.6 L	304 15.2 L
183 12.7 Dr	298 12.1 Pt	R CAE	313 7.8 Dr	299 10.6 Pt	306[13.5 B
236 12.6 Dr	300 12.0 Bg	*043738*	R AUR	301 10.6 Pt	309[11.5 Pt
263 12.0 Ht	324 12.7 Bg	183 10.3 Dr	050953	302 10.6 Pt	311[13.8 Lg
267 10.9 En	326 12.2 Ma	236 7.5 Dr	298 10.5 Pt	303 10.2 L	320[12.1 Pt
268 11.8 Ht	W TAU	*263* 9.0 Ht	304 9.4 Wd	303 10.7 Ma	326[12.2 Ma
277 11.0 Ht	042215	*268* 9.4 Ht	T PIC	304 10.3 L	S COL
301 8.6 Dr	289 11.4 L	268 9.1 En	051247	304 10.4 Pt	054331
313 8.0 Dr	295 10.9 Fd	274 9.0 En	236 7.7 Dr	320 10.5 Pt	236 9.3 Dr
U ARI	298 11.0 Pt	277 9.5 Ht	263 8.9 Ht	326 10.8 Ma	263 10.5 Ht
030514	300 11.0 Fd	297 9.8 Dr	268 9.0 Ht	327 11.0 Gc	268 10.6 Ht
293 14.8 L	300 10.7 Bw	313 9.9 Dr	268 9.1 En	AN ORI	274 10.8 En
306[14.0 B	306 10.2 B	R PIC	274 9.6 En	*053005t*	277 10.9 Ht
X CET	308 10.8 Bw	*044349*	277 10.0 Ht	287 11.6 L	297 11.3 Dr
031401	320 10.8 Fd	183 8.5 Dr	297 11.5 Dr	289 11.6 L	Z TAU
286 8.5 L	S TAU	236 9.6 Dr	NOV TAU	293 11.3 L	054615a
298 8.6 Pt	042309	263 9.2 Ht	051316	297 11.7 L	293 13.3 L
300 9.0 Sf	298 13.7 Pt	268 9.2 En	293 14.3 L	303 11.4 Ma	298 13.2 BE
303 8.7 Sf	303 13.5 Ma	268 9.0 Ht	T COL	S CAM	304 13.1 Ma
320 9.2 Sf	326 13.1 Ma	274 8.5 En	*051533*	053068	RU TAU
323 9.2 Sf	T CAM	277 8.6 Ht	183 8.7 Dr	298 9.0 Pt	054615c
Y PER	043065	297 7.7 Dr	236 12.0 Dr	RR TAU	293[14.0 L
032043	288 9.5 L	313 7.7 Dr	263 12.7 Ht	053326	304 13.3 Ma
290 8.8 Ah	298 10.2 Pt		268 12.4 Ht	286 10.6 L	326[12.6 Ma
298 8.2 Me	302 10.2 BL		274 12.4 En	287 10.9 L	

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
R COL	R OCT	V CMI	S CMI	X UMA	RR HYA
054629	*055686*	070109	*072708*	083350	*094023*
236 8.8 Dr	297 11.2 Dr	290 9.7 L	326 9.5 Fe	299 10.0 Pt	179 9.9 Dr
263 8.4 Ht	X AUR	296 10.4 Pt	T CMI	S HYA	294 14.2 L
268 8.4 Ht	060450	303 11.3 L	072811	084803	R LEO
274 8.2 En	289 10.8 L	304 10.6 Bw	290 12.2 L	299 8.7 Pt	094211
277 8.6 Ht	298 11.5 Pt	R GEM	296 12.4 Pt	T HYA	295 9.5 Ah
297 9.2 Dr	V AUR	070122a	303 12.4 L	*085008*	299 9.4 Pt
313 9.7 Dr	061647	295 9.0 Fd	S VOL	289 10.1 L	304 9.9 Wd
α ORI	291 11.4 L	295 8.9 Ah	*073173*	303 9.9 Tf	305 9.2 Mc
054907	V MON	296 8.5 Pt	173 9.5 Dr	303 9.8 L	309 9.8 Ma
275 0.2 Sl	*061702*	300 8.8 Wd	233 12.5 Dr	T CNC	309 9.8 Ah
292 0.4 L	299 10.7 Pt	303 8.9 Wd	277[13.2 Ht	085120	310 9.8 Ah
327 0.4 Mc	AG AUR	304 8.8 Wd	U CMI	299 8.8 Pt	L CAR
329 0.5 Mc	062047	306 8.3 Ah	073508	V UMA	*094262*
U ORI	289 10.2 L	307 8.2 Ah	290 9.3 L	090151	096 3.4 Dr
054920a	303 10.6 L	309 8.1 Ah	296 8.7 Pt	290 9.4 L	145 3.8 Dr
275 6.5 Sl	R MON	310 8.2 Ah	303 8.0 L	329 9.6 Mc	151 4.1 Dr
295 6.5 Ah	063308	310 8.5 Wd	S GEM	W CNC	173 3.6 Dr
295 6.7 Fd	299 12.5 Pt	319 7.9 Wd	073723	090425	179 3.7 Dr
298 6.3 Pt	Nov PIC	Z GEM	296 8.7 Pt	290 12.0 L	233 3.6 Dr
299 6.7 Ah	*063462*	070122b	312 8.8 Gc	RX UMA	236 3.5 Dr
300 6.7 Fd	263 8.4 Ht	296 12.4 Pt	327 8.9 Gc	090567	Y HYA
300 6.3 Wd	268 8.4 Ht	TW GEM	W PUP	290 11.2 L	*094622*
306 6.5 Ah	274 8.3 En	070122c	*074241*	RW CAR	299 6.8 Pt
310 6.6 Ah	277 8.4 Ht	296 8.4 Pt	173 8.5 Dr	*091868*	Z VEL
319 6.8 Wd	S LYN	R CMI	236 12.4 Dr	173 9.6 Dr	*094953*
320 7.0 Fd	063558	070310	263 9.6 Ht	233 12.0 Dr	174 12.2 Dr
329 7.6 Mc	291 10.9 L	290 9.3 L	268 9.2 Ht	263[12.2 Ht	268 10.0 Ht
V CAM	312 11.6 Gc	296 10.5 Pt	277 8.8 Ht	268[12.8 Ht	277 9.8 Ht
054974	X GEM	303 9.8 L	T GEM	277[12.8 Ht	V LEO
295 13.8 L	064030	R VOL	074323	Y VEL	095421
Z AUR	300 10.0 Bw	*070772*	296 9.1 Pt	*092551*	299 9.0 Pt
055353	308 10.0 Bw	173 13.4 Dr	300 8.6 Bw	174 12.2 Dr	309 9.1 Ma
294 10.2 Pt	Y MON	233 13.5 Dr	309 8.2 Ma	277[12.9 Ht	RR CAR
295 10.6 Pt	065111	263 12.6 Ht	R CNC	R CAR	*095458*
296 10.3 Pt	290 10.8 L	268 12.4 Ht	081112	*092962*	268 7.9 Ht
298 10.8 Pt	299 10.3 Pt	277 12.6 Ht	296 11.5 Pt	173 7.7 Dr	277 7.9 Ht
299 10.6 Pt	304 10.1 Ma	313 10.6 Dr	V CNC	179 7.2 Dr	RV CAR
300 10.6 Pt	X MON	L_2 PUP	081617	232 5.3 Dr	*095563*
300 10.9 Fd	*065208*	*071044*	289 9.9 L	236 5.2 Dr	174 13.9 Dr
301 10.5 Pt	289 7.9 L	172 5.4 Dr	296 9.8 Pt	263 4.2 Ht	277[13.1 Ht
302 10.6 Pt	291 8.1 Tf	236 3.7 Dr	301 9.2 Gy	268 4.3 Ht	S CAR
303 10.5 Pt	297 7.8 Dr	275 4.5 Sl	303 9.1 L	274 4.2 Sl	*100661*
304 10.7 Pt	298 8.1 Tf	297 4.8 Dr	310 9.0 Ah	277 4.3 Ht	171 8.4 Dr
309 10.8 Pt	303 8.2 Tf	313 5.3 Dr	RT HYA	X HYA	179 8.5 Dr
312 10.6 Pt	303 7.9 L	RR MON	*082405*	*093014*	232 6.4 Dr
313 10.6 Pt	313 8.3 Dr	071201	299 7.8 Pt	299 10.0 Pt	236 6.2 Dr
320 10.5 Pt	R LYN	312[12.8 Gc	R CHA	301 10.7 Gy	268 5.5 Ht
320 10.5 Fd	065355	V GEM	*082476*	Y DRA	275 5.6 Sl
322 10.6 Pt	291 9.6 L	071713	263 10.5 Ht	093178	277 5.8 Ht
R OCT	295 9.4 Ah	292 13.6 L	268 10.4 Ht	290 9.5 L	Z CAR
055686	299 9.5 Ah	304[13.4 Bw	277 9.7 Ht	304 10.0 L	*101058a*
173 7.6 Dr	304 9.3 Ma	312[12.8 Gc	U CNC	R LMI	277[12.3 Ht
233 9.9 Dr	306 9.7 Ah	S CMI	083019	093934	W VEL
262 10.4 En	Z CMA	072708	289 9.3 L	299 11.8 Pt	*101153*
263 10.6 Ht	*065911*	295 8.6 Fd	303 9.0 L	301 12.1 Gy	173 10.7 Dr
268 10.5 Ht	275 10.3 Sl	296 8.3 Pt	309 9.6 Ma	RR HYA	277[12.0 Ht
268 10.4 En		298 8.7 Tf		*094023*	
277 10.9 Ht		303 8.9 Tf		179 9.9 Dr	

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
U HYA	AD CEN	S UMA	RT CEN	V BOO	W LIB
103212	*114858*	123961	*134236*	142539a	*153215*
290 4.9 L	277 9.4 Ht	290 8.2 Ah	233 9.3 Dr	299 8.6 Ah	236[13.5 Dr
303 5.2 L	W CEN	295 8.1 Ah	R CVN	305 8.2 Me	237[14.8 Dr
RZ CAR	*115058*	299 8.2 Ah	134440	310 8.5 Ah	266[12.1 Bl
103270	173 13.1 Dr	299 8.0 Pt	299 11.5 Pt	R CAM	S UMI
232 9.9 Dr	233 8.8 Dr	300 8.1 Sz	301[10.4 Gy	142584	153378
233 10.2 Dr	265 8.4 Bl	301 8.3 Gy	RX CEN	295 10.6 Ah	290 9.4 Ah
268 12.0 Ht	277 9.6 Ht	303 8.3 Wd	*134536*	Y LUP	293 9.0 Pt
277 12.2 Ht	SU VIR	308 7.8 Ah	233[13.0 Dr	*145254*	295 9.4 Ah
R UMA	120012	309 8.0 Ah	237 15.0 Dr	174 15.0 Dr	298 9.2 Me
103769	309 12.3 Ma	310 8.0 Ah	T APS	233 13.5 Dr	299 9.4 Ah
290 8.0 Ah	T VIR	310 8.2 Wd	*134677*	262 9.9 En	300 9.6 Sf
295 8.2 Ah	*120905*	327 7.7 Ma	173 10.6 Dr	265 9.5 Bl	301 9.8 Gy
299 8.3 Ah	288[11.8 L	RU VIR	179 10.1 Dr	S APS	304 9.8 Sf
299 7.7 Pt	294 13.2 L	124204	192 9.6 Dr	*145971*	320 10.0 Sf
300 8.0 Sz	R CRV	288 12.3 L	232 10.2 Dr	171 10.0 Dr	U LIB
301 8.2 Gy	*121418*	304 12.3 L	236 10.3 Dr	173 10.0 Dr	*153620a*
303 8.2 Tf	287 7.2 L	U VIR	263 11.7 Ht	179 10.0 Dr	173 10.1 Dr
303 8.2 Wd	299 8.0 Pt	124606	265 11.8 Bl	206 10.0 Dr	236 10.6 Dr
306 8.4 Ah	303 8.3 L	288 10.6 L	268 12.5 Ht	232 9.8 Dr	266[12.9 Bl
310 8.4 Wd	SS VIR	299 8.9 Pt	Z BOO	233 9.9 Dr	T NOR
319 8.1 Wd	*122001*	304 9.1 L	140113	236 9.8 Dr	*153654*
329 9.4 Mc	286 6.7 L	RV VIR	290 13.4 L	238 9.9 Dr	171 8.7 Dr
V HYA	303 6.8 L	*130212*	RU HYA	245 9.6 Dr	206 10.4 Dr
104620	T CVN	292 13.3 L	*140528*	262 10.0 En	232 12.2 Dr
287 6.7 L	122532	U OCT	233 8.1 Dr	263 10.0 Ht	262[12.8 En
299 6.7 Pt	299 10.5 Pt	*131283*	R CEN	265 10.0 Bl	277[12.2 Ht
303 6.7 L	Y VIR	173 9.4 Dr	*140959*	268 10.0 Ht	299[11.5 Dr
W LEO	*122803*	192 9.9 Dr	173 7.2 Dr	277 10.0 Ht	Z LIB
104814	294 12.6 L	232 11.8 Dr	179 7.1 Dr	278 10.0 En	*154020*
289 12.3 L	309 11.5 Ma	263 13.2 Ht	179 6.6 Dr	299 10.0 Dr	236 12.3 Dr
299 12.7 Pt	U CEN	265 12.6 Bl	206 5.8 Dr	301 9.7 Dr	266[12.4 Bl
303 12.6 L	*122854*	268 13.2 Ht	232 6.3 Dr	S SER	R CRB
309 12.5 Ma	173 13.3 Dr	V CVN	252 6.7 En	151714	154428
RS CAR	233 11.9 Dr	131546	262 6.8 En	290 9.7 L	290 6.1 Ah
110361	265 9.4 Bl	308 7.5 GD	262 6.8 Ht	S CRB	290 6.0 L
275[12.3 Sl	T UMA	V VIR	265 6.7 Bl	151731	291 6.0 L
S LEO	123160	*132202*	267 6.8 Ht	293 8.7 Pt	292 6.0 L
110506	295 11.2 Ah	294 11.5 L	274 6.7 Sl	299 8.7 Ah	293 6.1 Pt
289 12.2 L	299 11.0 Ah	R HYA	277 7.3 Ht	310 8.7 Ah	294 6.0 L
299 11.7 Pt	299 11.0 Pt	*132422*	U UMI	RS LIB	295 6.0 L
303 11.7 L	301 10.7 Gy	303 7.3 Tf	141567	*151822*	295 6.0 Mg
309 11.6 Ma	303 11.0 Wd	RV CEN	293 11.0 Pt	252 9.1 En	296 6.0 L
RY CAR	306 10.6 Ah	*133155*	295 11.2 Ah	262 7.7 Ht	298 6.1 Pt
111561	310 10.6 Ah	265 7.5 Bl	299 11.4 Ah	262 7.4 En	298 6.1 Me
173 10.8 Dr	310 10.8 Wd	T UMI	306 11.5 Ah	265 8.0 Bl	299 6.0 Ah
179 11.4 Dr	327 9.6 Ma	133273	S BOO	R NOR	299 6.1 Pt
277[12.7 Ht	R VIR	294 14.0 L	141954	*152849*	300 6.1 Pt
RS CEN	123307	T CEN	288 8.5 L	173 9.3 Dr	301 6.1 Pt
111661	299 8.8 Pt	*133633*	293 8.6 Pt	232 8.8 Dr	301 6.0 Gy
173 9.3 Dr	RS UMA	173 7.2 Dr	301 8.6 Gy	233 8.8 Dr	302 6.1 Pt
179 9.1 Dr	123459	179 7.6 Dr	304 8.9 L	262 9.6 En	303 6.1 Pt
232 10.6 Dr	299 9.1 Pt	232 6.2 Dr	RS VIR	262 9.9 Ht	303 6.0 Wd
236 10.7 Dr	301 9.5 Gy	233 6.0 Dr	142205	265 9.6 Bl	303 6.0 L
277 12.7 Ht	303 8.9 Wd	236 5.8 Dr	288 8.4 L	268 10.1 Ht	304 6.0 L
X CEN	310 9.5 Wd	RT CEN	V BOO	X LIB	305 6.0 Me
114441	327 10.2 Ma	*134236*	142539a	*153020*	307 6.1 Ah
173 12.8 Dr		173 10.1 Dr	290 8.3 Ah	265[12.0 Bl	308 6.0 Mg
232 8.5 Dr		232 9.4 Dr	293 8.0 Pt		310 6.1 Ah

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J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

R CrB
154428
313 6.0 Me
313 6.1 Pt
X CrB
154536
290 11.1 L
293 9.8 Pt
R Ser
154615
293 8.0 Pt
V CrB
154639
293 7.2 Pt
301 8.2 BL
R Lup
154736
173 10.8 Dr
206 9.6 Dr
232 9.7 Dr
233 9.7 Dr
262 10.8 En
RR Lib
155018
236 14.3 Dr
Z CrB
155229
290 12.3 L
RZ Sco
155823
252 10.8 En
262 9.7 Ht
263 9.5 En
267 9.5 Ht
Z Sco
160021
252 9.6 En
262 9.6 Ht
263 9.9 En
265 9.5 Bl
267 9.7 Ht
RR Her
160150
298 9.0 Me
X Sco
160221a
266 12.7 Bl
SX Her
160325
290 8.0 L
293 8.0 Pt
298 7.8 Pt
299 8.0 Pt
301 8.0 Pt
302 8.0 Pt
303 8.0 Pt
305 8.0 L
313 8.1 Pt

W Sco
160519
174[14.0 Dr
236[13.6 Dr
237 14.3 Dr
266[12.6 Bl
RU Her
160625a
290 13.6 L
R Sco
161122a
262[12.6 Ht
263[12.6 En
265[12.4 Bl
S Sco
161122b
262[12.6 Ht
263[12.6 En
265[12.4 Bl
W CrB
161138
293 7.4 Pt
U Her
162119
293 7.7 Pt
303 7.2 Sf
SS Her
162807
289 10.1 L
T Oph
162815
236[13.0 Dr
266[12.8 Bl
S Oph
162816
173 11.1 Dr
236[13.8 Dr
266[12.6 Bl
W Her
163137
293 9.8 Pt
303 8.3 Sf
R UMi
163172
327 9.6 Mc
R Dra
163266
290 8.4 Ah
293 7.8 Pt
295 8.1 Ah
299 7.9 Ah
300 7.6 Fd
300 8.1 Wd
301 7.4 Gy
303 7.9 Wd
303 7.5 Ma
303 7.6 Fd
304 7.9 Wd
306 7.8 Ah
308 7.9 Ah

R Dra
163266
310 7.9 Ah
320 7.7 Fd
RR Oph
164319
252 9.2 En
262 10.2 En
S Her
164715
293 11.6 Pt
RS Sco
164844
173 6.3 Dr
206 7.8 Dr
232 9.0 Dr
252 10.0 En
262 10.4 En
262 10.1 Ht
265 10.2 Bl
267 10.4 Ht
268 10.6 En
277 10.8 Ht
RR Sco
165030a
173 6.1 Dr
206 7.0 Dr
232 8.1 Dr
252 9.5 En
262 10.4 En
262 10.8 Ht
264 10.5 Sl
265 10.3 Bl
267 10.8 Ht
274 10.8 Sl
277 11.2 Ht
280 11.0 Sl
RV Her
165631
287 10.9 L
293 11.2 Pt
305 12.2 L
RT Sco
165636
206 9.1 Dr
232 8.8 Dr
233 8.6 Dr
262 8.6 En
265 8.8 Bl
268 8.7 En
299 9.2 Dr
— Dra
165752
292 8.7 L
305 9.3 L
RT Her
170627
287 9.9 L
293 9.8 Pt
305 10.9 L

RW Sco
170833
206 11.4 Dr
232 8.9 Dr
233 8.7 Dr
263 9.4 En
265 9.4 Bl
268 9.6 En
299 10.7 Dr
Z Oph
171401
293 10.5 Pt
RS Her
171723
290 8.7 Ah
293 8.4 Pt
299 8.9 Ah
307 9.0 Ah
310 9.1 Ah
S Oct
172486
233 8.7 Dr
262 9.1 En
263 9.5 Ht
265 9.5 Bl
268 10.0 Ht
268 9.2 En
277 10.0 Ht
301 10.5 Dr
RU Oph
172809
291 9.3 L
293 9.0 Pt
301 9.4 BL
305 9.3 L
RT Ser
173411
291 12.8 L
RU Sco
173543
173 10.3 Dr
206 9.9 Dr
232 9.7 Dr
233 9.5 Dr
262 9.1 En
265 8.6 Bl
267 9.1 En
301 9.5 Dr
SV Sco
174135
174 12.4 Dr
233 10.4 Dr
262 10.1 En
265 10.3 Bl
268 10.1 En
301 11.3 Dr
W Pav
174162
233 9.4 Dr
262 9.6 En

W Pav
174162
262 9.7 Ht
265 9.8 Bl
267 9.9 Ht
267 9.7 En
277 10.4 Ht
301 11.6 Dr
RS Oph
174406
293 11.2 Pt
U Ara
174551
173 11.4 Dr
245 13.6 Dr
262 12.7 Ht
267 12.5 Ht
268 12.6 En
276 12.3 En
277 11.6 Ht
301 10.0 Dr
RT Oph
175111
292 14.4 L
T Dra
175458a
301 10.7 BL
UY Dra
175458b
301 10.7 BL
RY Her
175519
290 14.0 L
291[13.5 B
V Dra
175654
287 12.2 L
305 12.0 L
R Pav
180863
173 9.5 Dr
206 11.8 Dr
232 12.8 Dr
245 13.1 Dr
262[11.9 En
277[12.3 Ht
301[12.7 Dr
T Her
180531
287 11.9 L
290 10.4 Ah
293 11.5 Pt
299 10.4 Ah
300 10.4 Fd
305 10.6 L
306 9.6 Ah
W Dra
180565
292 14.4 L
293 13.5 Pt

X Dra
180666
292 14.1 L
301 10.9 Gy
TV Her
181031
290 14.1 L
RY Oph
181103
264 8.6 Sl
273 9.1 Sl
280 9.8 Sl
293 12.0 Pt
W Lyr
181136
287 11.3 L
293 11.4 Pt
293 11.0 B
299 10.3 Ah
304 10.1 Sf
304 10.2 Wd
304 11.0 L
306 9.8 Ah
320 9.0 Sf
RV Sgr
182133
173 8.9 Dr
206 11.0 Dr
233 12.4 Dr
266 13.1 Bl
SV Her
182224
287 10.9 L
298 11.0 Pt
304 11.3 Bw
T Ser
182306
291 12.5 B
298 12.7 Pt
SV Dra
183149
289 10.5 L
303 10.0 Ma
304 10.2 L
326 10.2 Fe
RZ Her
183225
291 14.4 L
X Oph
183308
289 8.6 L
298 8.2 Pt
RY Lyr
184134
295 15.2 L
R Sct
184205
264 6.1 Sl
273 6.2 Sl
281 6.2 Sl

VARIABLE STAR OBSERVATIONS RECEIVED DURING DECEMBER, 1930.

J.D.Est.	Obs.	J.D.Est.	Obs.	J.D.Est.	Obs.	J.D.Est.	Obs.	J.D.Est.	Obs.	J.D.Est.	Obs.
R Sct		T CrA		RU Lyr		S Sgr		RV Aql		S Pav	
184205		*185537b*		190941		*191319a*		193509		*194659*	
287	6.1 L	266	13.0 Bl	298	13.8 Pt	266[	12.9 Bl	288	11.9 L	233	7.4 Dr
288	6.1 Tf	267	12.5 Ht	U Dra		267[	12.9 Ht	293	11.8 Pt	263	7.8 En
291	6.4 GD	274	13.7 Sl	190967		291	14.2 L	T Pav		274	8.1 En
292	6.1 Bc	Z Lyr		290	10.1 L	Z Sgr		*193972*		301	8.4 Dr
293	6.1 Bc	185634		298	10.7 Pt	*191321*		206	10.4 Dr	RR Sgr	
293	6.3 Pt	296	13.0 B	300	10.9 Fd	263[	12.4 En	233	8.7 Dr	*194929*	
294	6.1 Pt	298	13.0 Pt	300	11.0 Gh	274[	12.1 En	262	8.9 Ht	173	10.5 Dr
296	6.1 L	SU Sgr		304	10.9 L	SW Sgr		263	8.9 En	233	13.0 Dr
297	6.0 Tf	*185722*		320	11.9 Fd	*191331*		267	8.2 Ht	263	13.0 En
298	6.1 Pt	262	8.4 Ht	W Aql		296	10.0 Dr	267	9.0 Bl	267	13.0 Bl
299	6.0 Pt	267	8.4 Ht	*191007*		233	10.7 Dr	274	9.3 En	301	12.5 Dr
300	5.6 Pt	277	8.2 Ht	298	8.6 Pt	263	12.4 En	277	9.5 Ht	RU Sgr	
300	5.9 Bg	RT Lyr		T Sgr		267	12.3 Bl	301	10.0 Dr	*195142*	
300	6.0 Fd	185737		*191017*		274	12.9 En	RT Cyg		206	12.4 Dr
301	5.6 Pt	289	12.3 L	291	9.9 L	301	13.0 Dr	194048		233	12.0 Dr
302	5.6 Pt	304	12.3 L	298	11.0 Pt	TZ Cyg		290	9.3 Ah	262	8.8 Ht
302	5.7 Tf	R Aql		R Sgr		191350		293	8.8 Pt	267	8.1 Ht
303	5.7 Pt	190108		*191019*		298	11.5 Pt	295	9.0 Ah	267	7.7 Bl
304	6.0 Wd	290	8.6 Ah	262	10.0 Ht	300	11.2 Gh	299	8.6 Ah	268	8.0 En
305	5.9 L	298	8.1 Pt	263	10.0 En	U Lyr		300	9.4 Fd	274	7.6 En
308	6.0 GD	299	8.2 Ah	267	10.4 Ht	191637		301	8.3 Gy	277	6.8 Ht
311	5.6 Tf	300	7.9 B	274	10.4 En	288	10.8 Rs	302	7.8 B	301	7.1 Dr
313	5.6 Pt	307	7.9 Ah	277	10.4 Ht	300	11.0 Fd	306	7.5 Ah	RR Aql	
320	5.6 Pt	RX Sgr		288	11.0 L	304	10.8 Rs	308	7.5 Ah	*195202*	
Nov Aql		*190818*		298	11.1 Pt	320	11.4 Fd	310	7.5 Ah	290	11.6 L
184300		263[	12.4 En	RY Sgr		AF Cyg		320	7.2 Fd	293	11.4 Pt
293	11.6 Pt	267[	12.4 Ht	*191033*		192745		TU Cyg		RS Aql	
299	11.6 Pt	290[	13.1 L	171[	13.2 Dr	287	6.7 Ah	194348		*195308*	
313	11.7 Pt	RW Sgr		173	13.4 Dr	290	6.5 Ah	290	12.1 L	295	13.9 L
320	11.7 Pt	*190819a*		174	13.5 Dr	295	6.5 Ah	293	12.0 Pt	300[	13.0 B
RX Lyr		262	9.9 Ht	179	13.8 Dr	299	6.4 Ah	301	11.5 B	Nov Cyg	
185032		263	9.2 En	183[	13.2 Dr	306	6.3 Ah	304	11.5 Rs	195553	
289	13.7 L	267	9.9 Ht	201	13.2 Dr	308	6.5 Ah	X Aql		294[	12.2 Pt
R Lyr		277	9.3 Ht	206	13.5 Dr	310	6.6 Ah	194604		299[	12.2 Pt
185243		278	8.7 En	232	13.3 Dr	TY Cyg		288	9.4 L	309[	12.2 Pt
327	4.6 Mc	290	8.6 L	233	12.8 Dr	192928		293	8.9 Pt	320[	12.2 Pt
S CrA		298	8.9 Pt	236	13.0 Dr	290	13.6 L	300	10.2 Sf	RR Tel	
185437a		BH Sgr		238	12.9 Dr	RT Aql		302	10.0 Tf	*195656*	
262	12.5 Ht	*190819b*		245	12.9 Dr	193311		302	10.3 B	262	12.6 Ht
263	11.7 En	290	12.2 L	245	13.0 Dr	288	10.8 L	304	10.6 Sf	263	12.6 En
264	12.2 Sl	TY Aql		262[	12.5 En	298	11.4 Pt	X Cyg		267	12.8 Ht
266	11.9 Bl	*190907*		266[	12.5 Bl	R Cyg		194632		Z Cyg	
267	12.0 Ht	298	10.5 Pt	275	13.4 Dr	193449		290	9.6 Ah	195849	
274	12.1 Sl	S Lyr		277[	11.6 Ht	290	9.9 Ah	293	9.5 Pt	290	11.2 L
ST Sgr		190925		290	12.7 L	293	9.6 Pt	295	9.7 Ah	294	10.3 Pt
185512a		289	12.3 L	296[	12.3 L	295	9.9 Ah	299	9.8 Ah	300	10.7 B
290	10.5 L	298	11.7 Pt	297	14.2 Dr	297	9.8 Fd	300	9.6 Bg	300	11.4 Rs
R CrA		304	11.9 L	298[	12.0 Pt	299	10.1 Ah	300	9.9 Wd	304	10.6 Rs
185537a		X Lyr		299	14.0 Dr	300	9.8 Fd	304	10.2 Wd	308	10.5 Rs
262	12.5 Ht	190926		301[	12.7 Dr	300	9.7 Wd	306	9.7 Ma	320	9.8 Me
263	13.0 En	298	9.2 Pt	TY Sgr		301	9.9 Gy	306	10.5 Ah	S Tel	
266	13.5 Bl	RS Lyr		*191124*		303	9.7 Ma	306	9.9 Mg	*195855*	
267	12.5 Ht	190933a		266[	12.4 Bl	304	9.9 Wd	313	10.0 Bg	262	12.8 Ht
274	13.7 Sl	299	13.8 L	274[	12.1 En	310	10.5 Ah	320	10.5 Bg	263	13.0 En
T CrA		308	13.0 Bw	301[	13.0 Dr	319	10.1 Wd	S Pav		267	13.1 Bl
185537b		RU Lyr		S Sgr		320	10.2 Fd	*194659*		267	12.9 Ht
262	12.5 Ht	190941		*191319a*		327	10.0 Mc	173	7.0 Dr		
263	13.0 En	295	13.3 L	263[	12.9 En			206	7.3 Dr		

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J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs. J.D.Est.Obs.

SY AQL
200212
288 10.2 L
294 10.6 Pt
296 9.8 B
S CYG
200357
290 12.7 L
294 12.6 Pt
300 12.4 B
R CAP
200514
292 11.4 L
294 11.0 Pt
302 11.0 B
S AQL
200715a
294 9.0 Pt
298 10.1 Me
303 10.4 B
306 10.5 Mg
320 11.0 Me
RW AQL
200715b
294 9.2 Pt
303 9.4 B
306 9.2 Mg
R TEL
200747
206 13.6 Dr
233 14.4 Dr
245 14.3 Dr
RU AQL
200812
288 11.7 L
299 11.9 B
W CAP
200822
267[13.3 L
Z AQL
200906
294 11.9 Pt
308 12.4 Bw
R SGE
200916
298 9.4 Me
RS CYG
200938
291 7.3 GD
294 7.0 Pt
298 7.6 Me
300 7.0 Wd
300 7.3 L
304 7.2 Wd
301 7.7 GD
319 7.6 GD
319 7.3 Wd
R DEL
201008
288 11.5 L

R DEL
201008
294 11.4 Pt
295 11.4 Ah
299 11.8 B
312 10.5 Mg
SX CYG
201130
292 13.6 L
308 13.5 Bw
RT SGR
201139
173 7.7 Dr
206 7.1 Dr
233 8.3 Dr
267 10.0 Bl
301 11.7 Dr
WX CYG
201437b
288 12.3 L
291 12.1 Rs
294 12.0 Pt
299 12.3 B
300 12.1 L
304 12.2 Rs
V SGE
201520
287 11.0 L
288 10.9 L
292 10.2 L
296 12.1 L
298 12.1 L
300 11.8 L
304 11.4 L
305 11.4 L
U CYG
201647
291 7.5 GD
294 7.1 Pt
297 7.9 Fd
298 7.8 Me
300 7.6 Fd
300 7.6 Sf
300 7.7 Wd
301 7.7 GD
303 7.3 B
304 7.6 Wd
310 7.5 Wd
319 7.5 Wd
319 7.9 GD
320 7.5 Me
320 7.6 Fd
320 7.6 GD
320 7.5 Sf
327 7.8 Mc
U MIC
202240
173 9.4 Dr
233 11.9 Dr
267 12.7 Bl

RW CYG
202539
298 8.5 Me
Z DEL
202817
294 13.0 Pt
ST CYG
202954
292 14.4 L
294 13.8 Pt
299 13.7 B
V VUL
203226
294 8.8 Pt
R MIC
203429
267 9.0 Bl
Y DEL
203611
288 10.6 L
294 11.0 Pt
296 10.6 B
S DEL
203816
294 11.6 Pt
296 10.8 B
312 11.7 Mg
V CYG
203847
291 8.1 L
294 8.5 Pt
300 9.6 Fd
300 10.0 Sf
303 9.0 B
320 9.7 Sf
Y AQR
203005
294 8.6 Pt
T DEL
204016
295 12.8 L
U DEL
204017
292 7.1 Tf
297 6.7 Tf
303 6.7 Tf
311 6.7 Tf
V AQR
204102
291 8.7 L
294 8.6 Pt
W AQR
204104
291 12.3 L
296 12.2 B
U CAP
204215
267[13.9 Bl
292 13.9 L

V DEL
204318
295 13.6 L
T AQR
204405
294 12.0 Pt
296 12.5 B
RZ CYG
204846
294 12.1 Pt
296 11.5 B
306 11.3 B
S IND
204954
173 8.7 Dr
192 7.8 Dr
233 8.9 Dr
263 10.8 Ht
267 10.5 Bl
268 10.8 Ht
277 11.4 Ht
301 12.7 Dr
X DEL
205017
291 11.7 L
296 10.5 B
RR CAP
205627
233[14.0 Dr
301 12.9 Dr
T OCT
205782
173 8.3 Dr
236 13.2 Dr
301[13.6 Dr
R VUL
205923a
294 9.4 Pt
295 9.3 Ah
296 9.4 B
299 9.1 Ah
306 8.8 Ah
320 7.3 Me
V CAP
210124
236 13.5 Dr
267 10.9 Bl
TW CYG
210129
291 13.5 L
300 13.3 B
X CAP
210221
294 11.6 Pt
267 13.3 Bl
X CEP
210382
291 13.9 L

RS AQR
210504
291 10.6 L
294 10.7 Pt
302 11.0 B
312 10.9 Mg
Z CAP
210516
294 13.8 Pt
301[13.5 B
R EQU
210812
291 9.7 L
294 9.3 Pt
T CEP
210868
288 6.5 Ah
290 6.5 Ah
294 6.4 Pt
295 6.6 Ah
299 6.5 Ah
300 6.7 Wd
301 6.6 Gy
304 6.7 Wd
306 6.2 Ah
308 6.3 Ah
310 6.3 Ah
310 6.4 Wd
319 6.2 Wd
320 6.2 Fd
321 6.0 GD
RR AQR
210903
291 12.0 L
294 12.5 Pt
299 12.3 Mg
302 12.7 B
304 12.7 L
312 12.3 Mg
Y PAV
211570
262 6.7 Ht
267 6.4 Ht
277 6.4 Ht
X PEG
211614
291 12.6 L
294 12.0 Pt
299 11.8 B
300 11.5 L
T CAP
211615
267 13.6 Bl
291 13.1 L
301 12.5 B
S MIC
212030
236 12.4 Dr
264 10.4 En
267 10.0 Bl

S MIC
212030
277 10.2 En
301 10.4 Dr
Y CAP
212814
267 12.6 Bl
292 13.5 L
W CYG
213244
288 5.6 L
300 5.7 L
S CEP
213678
294 8.5 Pt
RU CYG
213753
288 8.6 Ah
294 8.3 Pt
295 8.6 Ah
299 8.6 Ah
308 8.7 Bw
RV CYG
213937
298 6.5 Pt
RR PEG
214024
298 9.2 Pt
299 9.1 Mg
303 9.3 B
R GRU
214247
236 14.5 Dr
245 14.0 Dr
264[12.9 En
267[13.7 Bl
277[12.9 Ht
301 13.5 Dr
V PEG
215605
291 12.9 L
299 12.8 B
U AQR
215717
298 13.6 Pt
300[14.5 L
RT PEG
215934
290[14.0 L
RY PEG
220133a
300 12.1 B
RZ PEG
220133b
291 12.3 L
300 11.9 B
T PEG
220412
295 14.5 L

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J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.	J.D.Est.Obs.
Y PEG	S LAC	RW PEG	S PEG	R AQR	R TUC
220613	222439	225914	231508	*233815*	*235265*
293 11.5 L	293 9.1 L	298 9.7 BE	294 12.6 Pt	277 8.6 En	301 9.8 Dr
298 12.0 Pt	297 9.0 Tf	303 8.7 Ma	295 13.2 L	291 8.7 L	313 10.5 Dr
299 12.5 Mg	298 8.4 Pt	304 9.7 Sf	303 12.8 B	292 8.6 Tf	R CAS
300 12.3 B	300 8.5 B	320 9.9 Sf	V PHE	294 8.4 Pt	235350
RS PEG	303 8.7 Tf	β PEG	*232746*	297 8.8 Tf	295 10.6 Ah
220714	303 8.2 Al	225927	192 10.1 Dr	300 8.5 L	301 9.9 Gy
293 12.7 L	312 8.0 Mg	327 2.7 Mc	232 12.3 Dr	301 9.2 Al	303 10.6 Wd
298 11.8 Pt	R IND	R PEG	236 13.0 Dr	302 8.7 Tf	306 10.4 Ah
299 12.8 Mg	*222867*	230110	265[13.2 En	320 9.1 Me	Z PEG
300 12.3 B	236 9.1 Dr	294 10.4 Pt	277[13.2 Ht	Z CAS	235525
R PSA	262 11.0 Ht	298 10.3 Me	Z AND	233956	250 13.0 Lg
221230	267 11.8 Ht	300 10.3 Bg	232848	295 14.4 L	295 13.0 Pt
236 12.0 Dr	267 11.4 Bl	301 11.0 Gy	294 9.8 Pt	RR CAS	295 13.5 L
301[13.3 Dr	277 12.2 Ht	304 11.2 Sf	300 9.5 Bg	235053	311 12.3 Lg
T GRU	301 13.6 Dr	320 11.6 Sf	ST AND	303[12.2 Al	W CET
221948	T TUC	320 10.3 Me	233335	326[11.7 Fe	*235715*
192 9.5 Dr	*223462*	321 10.8 GD	294 11.0 Pt	R PHE	320 10.3 Fd
236 10.1 Dr	192 8.3 Dr	324 11.1 Bg	295 11.0 Fd	*235150*	Y CAS
263 12.0 En	236 10.3 Dr	V CAS	301 11.4 BL	236 10.1 Dr	235855
264 12.2 En	262 12.3 Ht	230759	301 11.3 Al	265 9.0 En	295 13.8 L
268 12.5 Ht	264 12.6 En	290 8.1 Al	303 11.4 BL	301 8.4 Dr	311 12.9 Lg
277 12.4 Ht	267 12.5 Ht	294 8.3 Pt	309 11.4 BL	313 8.6 Dr	SV AND
277 12.4 En	277 13.0 Ht	295 8.2 Ah	313 11.3 BL	V CET	235939
301 12.8 Dr	301 13.2 Dr	298 8.2 Me	315 11.2 BL	*235209*	261[13.0 B
RV PEG	R LAC	303 9.2 Sf	320 11.1 BL	267 10.7 Bl	264[12.9 Mg
222129	223841	306 8.7 Ah	321 11.0 BL	297 10.4 L	271 13.5 Pt
295 13.9 L	293 12.6 L	320 10.0 Sf	322 10.9 BL	R TUC	272[12.3 Md
326[12.3 Fe	298 12.4 Pt	320 9.7 Me	R AQR	*235265*	291[13.1 Gc
	RW PEG	W PEG	*233815*	263 9.7 Ht	294 13.5 Pt
	225914	231425	263 8.2 Ht	264 9.1 En	301[12.9 Mg
	293 8.9 L	295 11.0 L	264 8.7 En	268 9.5 Ht	311 13.3 Lg
	294 9.4 Pt	299 11.6 Mg	267 8.4 Bl	277 9.3 Ht	
		303 11.2 Al	268 8.3 Ht	277 9.3 En	
		321 11.7 Bw	277 8.3 Ht		

RAPIDLY VARYING IRREGULAR VARIABLES.

Star J.D. Est.Obs.	J.D. Est.Obs.	Star J.D. Est.Obs.	J.D. Est.Obs.
005840 RX ANDROMEDAE—		060457 SS AURIGAE—	
6288.3 13.1 L	6298.2 13.1 L	6296.7 14.7 L	6303.6 13.8 B
6289.3 12.8 L	6298.7 13.0 Pt	6297.7 13.3 L	6303.6 13.6 L
6289.6 11.4 L	6299.7 13.0 Pt	6298.2 11.5 L	6304.4 14.0 L
6290.3 11.0 L	6300.3 13.0 L	6298.7 11.4 Pt	6304.7 14.2 L
6290.6 10.7 L	6300.7 12.5 Pt	6299.6 11.6 B	6306.6[13.8 B
6291.2 10.9 L	6301.7 11.5 Pt	6299.7 11.0 Pt	6308.6 14.0 Bw
6293.3 12.2 L	6302.7 11.5 Pt	6300.3 11.5 L	6309.7[12.6 Pt
6293.6 12.5 Br	6303.6 11.5 Pt	6300.6 11.7 B	6311.7[14.2 Lg
6293.7 11.4 Pt	6303.6 10.8 L	6300.7 11.6 Pt	6312.7[12.4 Pt
6294.6 12.4 L	6305.2 12.2 L	6300.7 11.6 Bw	6313.6[11.0 Pt
6294.7 12.0 Pt	6309.7 13.0 Pt	6301.6 12.3 B	6320.6 11.2 Pt
6295.7 13.0 Pt	6310.6 13.4 Br	6301.7 12.7 Pt	6322.6 12.7 Pt
6295.7 13.1 L	6312.7 11.5 Pt	6302.6 12.9 B	6326.7[12.6 Fe
6296.2 12.9 L	6313.6 11.5 Pt	074922 U GEMINORUM—	
060547 SS AURIGAE—		6286.7 13.8 L	6291.7[14.0 L
6286.3[12.4 L	6291.7[13.3 L	6287.7[13.3 L	6293.5[13.8 L
6287.7[12.4 L	6293.7[12.0 Pt	6288.7 13.9 L	6294.7 14.0 L
6288.7[14.0 L	6294.7 14.7 L	6289.7[13.8 L	6295.7 13.9 L
6289.7[13.3 L	6295.7 14.5 L	6290.7[13.8 L	6296.7 14.1 L

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Star	J.D.	Est.Obs.	J.D.	Est.Obs.
074922 U GEMINORUM—				
	6297.7	13.9 L	6304.7	14.0 L
	6299.9[	13.3 Pt	6309.7	13.5 Bw
	6301.7[	12.4 Pt	6309.8	14.0 Ma
	6302.8[	13.3 Pt	6311.7	13.9 Lg
	6303.7	13.9 L	6320.6[	11.2 Pt
081473 Z CAMELOPARDALIS—				
	6286.3	11.7 L	6295.7	11.5 L
	6286.7	11.6 L	6296.3	11.6 L
	6287.3	11.6 L	6296.7	11.7 L
	6288.3	11.5 L	6297.7	11.6 L
	6289.3	11.5 L	6298.2	11.5 L
	6290.3	11.9 L	6300.2	11.7 L
	6290.7	11.8 L	6303.7	11.8 L
	6291.3	11.9 L	6304.7	11.8 L
	6293.5	11.9 L	6305.2	11.9 L
	6294.7	11.8 L	6311.7	11.5 Lg
	6295.3	11.6 L		
094512 X LEONIS—				
	6286.7	13.8 L	6296.7[	14.2 L
	6287.7[	13.8 L	6297.7[	14.7 L
	6288.7[	13.8 L	6303.7[	14.7 L
	6294.7[	13.8 L	6304.7	12.3 L
	6295.7[	14.2 L		
202946 SZ CYGNI—				
	6293.7	8.8 Pt	6301.7	9.7 Pt
	6294.7	8.8 Pt	6302.7	9.7 Pt
	6295.7	8.8 Pt	6303.6	9.6 Pt
	6296.8	9.0 Pt	6304.8	9.4 Pt
	6298.7	9.3 Pt	6309.7	8.7 Pt
	6300.7	9.6 Pt	6312.7	8.8 Pt
202946 SZ CYGNI—				
	6313.6	8.9 Pt	6322.6	8.9 Pt
	6320.6	9.2 Pt		
213843 SS CYGNI—				
	6287.3	12.1 L	6301.7	11.7 Pt
	6288.3	12.0 L	6302.7	11.6 Pt
	6289.3	12.0 L	6306.3	11.8 Ah
	6290.4	12.1 L	6303.6	11.9 Al
	6291.4	12.0 L	6303.6	12.0 B
	6292.4	12.2 L	6303.6	12.0 Fd
	6293.5	12.0 L	6303.6	11.6 Pt
	6293.6	11.9 Br	6303.7	11.9 Ma
	6293.6	12.0 Bc	6304.3	12.2 L
	6293.7	11.8 Pt	6304.6	12.0 Wd
	6294.7	11.7 Pt	6304.8	11.7 Pt
	6295.3	12.1 L	6305.3	12.1 L
	6295.3	11.8 Ah	6306.6	12.0 B
	6295.7	11.7 Pt	6308.4	11.8 Ah
	6296.3	12.1 L	6309.7	11.8 Pt
	6296.8	11.7 Pt	6310.6	11.9 Br
	6297.6	11.9 Fd	6311.5	11.9 Lg
	6298.2	12.3 L	6312.6	12.0 Mg
	6298.7	11.7 Pt	6312.7	11.7 Pt
	6299.3	11.8 Ah	6313.6	11.8 Pt
	6299.6	11.9 B	6319.6	11.4 Wd
	6300.3	12.2 L	6320.6	11.8 Fd
	6300.6	11.5 Sz	6320.6	11.6 Pt
	6300.6	11.6 B	6322.6	11.4 Pt
	6300.6	12.0 Fd	6323.5	9.9 Sf
	6300.6	11.6 Wd	6326.6	8.3 Fe
	6300.7	11.7 Pt	6326.7	8.8 Ma
	6301.6	12.0 B		

SUMMARY FOR DECEMBER, 1930.

Observer	Initial	Vars.	Observations	Observer	Initial	Vars.	Observations
Ahnert	Ah	40	144	Guiler	Gc	7	7
Allen, P. R.	Al	10	10	Houghton	Ht	74	161
Baldwin	Bl	54	54	Lacchini	L	178	333
Beloit College	BE	4	4	Logan	Lg	14	16
Bigelow	Bw	18	21	Marsh	Ma	39	59
Boutell	BL	13	48	McLeod	Mc	11	12
Bouton	B	57	67	Meek	Me	21	26
Brocchi	Br	7	9	Monnig	Mg	23	26
Buckstaff	Bc	2	3	Peltier	Pt	192	319
Bunting	Bg	6	12	Ross	Rs	4	10
Dartayet	Dr	98	308	Shinkfield	Sl	17	29
Ensor	En	70	105	Shultz	Sz	4	4
Ferris	Fe	8	8	Smith, F. W.	Sf	15	31
Ford	Fd	25	46	Taffara	Tf	17	40
Godfrey Club	GD	6	12	Webb	Wd	22	49
Gooch	Gh	2	2				
Gregory	Gy	21	21	Totals		32	428 1986

A.A.V.S.O. Bulletin, said bulletin to print information of temporary and immediate value to its members, such as the bi-monthly predictions of magnitudes of the long period variables, notes on important occultations, meteor showers, etc. The

first two issues of this proposed bulletin will be sent gratis to all members, succeeding issues to all active members. Active members are those who take an active interest in the affairs of the Association, whether by contributing observations or otherwise.

The fact that fewer observations are reported herewith is doubtless due to the excessive cloudiness of the past month or more reported from nearly all parts of the world. The number of contributors, and number of variables observed differ little from those of recent reports.

Sr. Dartayet, of La Plata, contributes a lengthy report after a period of quietude covering many months, mainly caused by a serious illness. We are pleased to welcome him back to the active list.

LEON CAMPBELL, Recording Secretary.

January 12, 1931.

METEOR NOTES

By CHARLES P. OLIVIER.

Since last month several additional sets of observations dealing with the Leonids have come in. The most extensive and valuable is from Tacubaya Observatory, Mexico, kindly furnished us through Harvard College Observatory. These fully confirm our former conclusions, namely that a very fine Leonid shower was visible to those favored with clear skies. We have also reports from twelve different ships at sea for the night of maximum, and more are expected. Reports from four of these ships were quoted from in the preceding "Meteor Notes." In all twelve cases fireballs, with long enduring trains, appeared as well as smaller meteors. The following abstracts from some of these reports deal with the night of November 16-17.

First Officer, *Br. S.S. Oilshipper*, Lat. 31° 31′ N, Long. 47° 44′ W, ". . . observed a shower of meteors during the morning watch (4:00 to 8:00 A.M.)."

Second Officer P. Agard, *Am. S.S. West Modus*, Lat. 26° 20′ N, Long. 65° 00′ W, ". . . from 6 to 8 hours G.M.T. (Civil) . . . observed about 35 meteors of all sizes. . . . Weather clear in the west, cloudy in the east."

Second Officer G. T. Bieling, *Am. S.S. Annetta*, Lat. 23° 22′ N, Long. 74° 22′ W, ". . . an immense shower of meteors was observed, the display lasting until daylight . . . As many as 12 to 15 a minute were observed near 0840 G.M.T. (Civil), which appeared to be the maximum of the display."

Second Officer A. H. Anderson, *Am. S.S. Republic*, Lat. 24° 32′ N, Long. 83° 00′ W, ". . . from 2:00 to 4:00 A.M. (ship time) about 110 meteors were counted."

Second Officer M. Bach, *Am. S.S. El Lago*, Lat. 25° 36′ N, Long. 84° 20′ W, ". . . during the middle watch (12:00 to 4:00 A.M.) . . . hundreds of shooting stars and meteors were observed . . ."

Second Officer J. Miguel, *Am. S.S. Kansan*, Lat. 17° 23′ N, Long. 102° 10′ W, ". . . From about 4:00 A.M. ship time to daylight several bright meteors were observed which left bright trains visible for about 15 to 20 seconds. For about two hours there were countless lesser bodies mostly shooting straight down."

Second Officer J. E. Carlson, *Am. S.S. Sierra*, Lat. 29° N, Long. 144° W, ". . . between 4:00 and 5:30 A.M. (ship time) . . . about 60 shooting stars were

counted. . ."

Nearly all of the above reports give detailed observations of from one to several fireballs seen during the course of the display. Later when all reports are available the writer hopes to discuss the density of the stream and determine its hour of maximum intensity.

As usual the period of the Bielid meteors passed without any display. This stream seems to have been wholly dispersed, and we can hardly hope for showers from it in the future. However, nothing is more uncertain than predictions as to meteor showers! On the contrary, the Geminids returned in about their usual strength, large numbers being recorded on December 12 and 13 by several of our regular observers, who got very good results. Their rates will be found in the following table. Many radiants can be worked out from their maps, and it is doubtless a matter of disappointment to our members that their radiants are so slow in being published. The writer must assure them, however, that quick determinations of radiants often lead to sad errors in judgment. It is far better to work them up and then lay aside the results for a time. Afterwards a fresh study will often permit the elimination of the uncertain and spurious cases. Also until the writer can obtain an assistant for the work of the A.M.S., it is inevitable that he can work up only a part of the data, as it is a matter of mutual congratulation that our work constantly grows in amount and value. Several special investigations are now under way and will soon be ready for publication. The annual report should appear as usual in the March "Meteor Notes."

We welcome the following new members to the A.M.S.:

Kenneth E. Gell, 713 Parsells Avenue, Rochester, New York.
Richard F. Gardner, 1474 Wager Avenue, Lakewood, Ohio.
Joseph Stevenson, 619 Rugby Road, Brooklyn, New York.
Prof. Ed. G. Howe, 10233 S. Wood Street, Chicago, Illinois.
Stuart L. O'Byrne, 501 Pacific Avenue, Webster Groves, Missouri.
Mrs. Isabella G. Payne, Fairhope, Alabama.
Walter Wood, 400 Chestnut Street, Philadelphia, Pennsylvania.
John L. Davis, 201 W. 89th Street, New York City.

If the Society continues to grow much more, it will be necessary to adopt eligibility rules and not elect anyone to membership until he has met certain more definite requirements than have so far been asked.

The writer desires to ask all members to pay special attention to the following change that we wish to make in our reports. Due to the continued confusion as to the Civil and old astronomical date, every observer is asked to please date his records by the double date system. As an example, if he worked tonight which is Civil date January 20 up to midnight and Civil date January 21 from midnight on, let him date it as January 20-21, *irrespective of whether he observes before or after midnight.* If all will observe this rule it will save continuous trouble and error in reducing their observations. We would also be glad if all would give their Standard Time belt, and in summer what sort of time they are using.

TEXAS GROUP.

O. E. Monnig, Fort Worth.

1930		Began	Ended	Total	Meteors	F	Rate	Cor.Rate	Remarks
Dec.	10	8:00	11:11	141	19	0.6	8.1	13.5	12 Geminids
	11	8:50	11:20	150	23	0.8	9.2	11.5	16 Geminids
	12	9:48	11:28	100	24	0.8	14.4	18.0	19 Geminids
	13	10:50	12:18	50	26	1.0	31.2	31.2	26 Geminids
	13	9:25	12:13	128	92	1.0	43.2	43.2	Count by John Durrett

MILTON MEHL, BURLESON.

1930	Began	Ended	Total	Meteors	F	Rate	Cor.Rate
Dec. 13	10:20	13:35	195	15	1.0	4.6	4.6

LINCOLN LA PAZ, COLUMBUS, OHIO.

1930	Began	Ended	Total	Meteors	F	Rate	Cor.Rate
Dec. 15	9:30	10:30	60	3	0.9	3.0	3.3
16	14:20	16:00	100	11	1.0	6.6	6.6

GORDON RIDLEY, ALAMEDA, CALIFORNIA.

1930	Began	Ended	Total	Meteors	F	Rate	Cor.Rate	Remarks
June 8	8:00	10:31	151	2	0.9	0.8	0.9	
9			70	5	0.5	4.3	8.6	
26	13:00	15:10	130	19	0.8	8.8	11.0	
27	13:00	15:15	135	17	1.0	7.6	7.6	
28	8:15	12:45	270	40	1.0	8.9	8.9	
29	8:15	13:50	305	34	1.0	6.7	6.7	
Dec. 9	13:00	14:00	60	4	0.5	4.0	8.0	Moon
11	13:00	15:20	140	25	0.6	10.7	17.8	Moon
12	13:00	16:00	180	88	0.6	29.3	48.8	
13	8:15	14:15	360	178	1.0	29.7	29.7	
14	10:40	14:10	210	44	1.0	12.6	12.6	
16	13:07	16:07	180	45	1.0	15.0	15.0	
17	13:10	15:50	160	26	1.0	9.8	9.8	
18	13:28	14:48	80	10	0.6	7.5	12.5	
19	13:05	15:05	120	22	1.0	11.0	11.0	

MRS. W. H. EDWARDS, FAIRHOPE, ALABAMA.

1930	Began	Ended	Total	Meteors	Rate	Cor.Rate	Remarks
Dec. 13	9:20	10:20	60	25			
	10:20	11:20	60	37			
	11:20	11:50	30	25			
			150	87	34.8	34.8	Counts

D. F. WAUGH, TOKYO, JAPAN.

1930	Began	Ended	Total	Meteors	F	Rate	Cor.Rate
Dec. 16	12:01	13:01	60	4	1.0	4.0	4.0

STUART L. O'BYRNE, WEBSTER GROVES, MISSOURI.

1930	Began	Ended	Total	Meteors	F	Remarks
Dec. 11	10:54	12:00	66	10	0.5	Restricted area of sky

F. K. SMITH, GLENOLDEN, PENNSYLVANIA.

1930	Began	Ended	Total	Meteors	F	Rate	Cor.Rate
Dec. 9	8:25	9:25	60	1	0.9	1.0	1.1

J. T. KENT AND MARVIN MOORE,
UNIVERSITY OF ARKANSAS, FAYETTEVILLE, ARKANSAS.

1930	Began	Ended	Total	Meteors	Remarks
Dec. 13	9:05	9:32	27	20	C.S.T. used; mostly Geminids.
	11:01	12:03	62	75	Two observers; counts.
	12:46	13:46	60	79	Several brilliant meteors.
	14:21	14:45	24	21	
			173	195	

A. KLAPPERICH, WILMETTE, ILLINOIS.

1930	Began	Ended	Total	Meteors	F	Rate	Cor.Rate	Remarks
Aug. 11	9:00	11:00	120	4	0.4	2.0	5.0	Count
12	9:00	12:00	180	7	0.4	2.3	5.8	Count
14	11:00	13:20	140	12	0.6	5.1	8.5	Count; 5 plotted

J. Leo Kenan, Havana, Cuba.

1930	Began	Ended	Total	Meteors	Remarks
Nov. 16	16:30	16:45	15	22	} 27 were Leonids,
	16:45	17:00	15	8	} all mapped

Tacubaya Observatory, Mexico,
Joaquin Gallo, Director.

1930	Began	Ended	N.E.	N.W.	S.E.	S.W.	Total	Remarks
Nov. 16	9:00	9:30	10	12	3	5	30	Four observers; heavy
	9:30	10:00	10	14	2	7	33	fog at 10:30.
	10:00	10:30	7	2	0	3	12	G.C.T. used.
			27	28	5	15	75	
Nov. 17	9:00	9:30	13	32	31	34	110	Four observers;
	9:30	10:00	26	33	29	43	131	G.C.T. used.
	10:00	10:30	31	40	41	55	167	
	10:30	11:00	35	46	38	37	156	
	11:00	11:30	44	32	27	41	144	
	11:30	12:00	13	15	8	19	55	
			162	198	174	229	763	

Note: Prof. Gallo wrote that some of the Leonids were very bright, but no so bright as those of 1928. Many were observed near the horizon and at zenith. He personally was with observers on both nights.

Flower Observatory, Upper Darby, Pennsylvania, 1931 January 20.

The Number of Meteors and Meteorites

For this estimation, meteors may conveniently be divided into three classes; first, those visible to the naked eye; second, telescopic meteors; and third, meteorites, stones or irons dropped to the surface of the earth by large meteors.

Naked-Eye Meteors.

This is the class ordinarily referred to when a textbook gives the daily number of meteors. It is well known that ten meteors per hour is the average number for one observer. Let us assume that for average meteors he can cover an area fifty degrees in diameter. If he is working near the zenith, this obviously includes the meteors over about 2000 square miles of the earth's surface; and as the entire area of the earth is approximately 200,000,000 square miles, the number of meteors for the whole earth must be about 1,000,000 per hour, or 24.000.000 per day.

As another method of attacking the problem, H. A. Newton experimented with groups of observers numbering from one to twelve, and found that a large group records at least six times as many as one observer, or 60 per hour on the average. It has been found that observers working at stations one hundred miles apart record in duplicate only a small per cent of the meteors observed. Sixty miles has been adopted as a liberal estimate of the distance at which an average meteor can be seen. This means that the large group, which records six times ten, or sixty, meteors per hour, records those over a circle of radius sixty miles, or over an area of about 12,000 square miles. From this, the number for the whole earth is 1,000,000 per hour, or 24,000,000 per day, agreeing with the above.

Telescopic Meteors.

This number is usually estimated from the observations of Winnecke and Pape; the former using a telescope with a field of 53′ and recording 45 meteors, while the latter recorded 312 naked-eye meteors in 32 hours of observing. If the

average telescopic meteor had a trail a little more than two degrees long, and was at the altitude of the average naked-eye meteor, Winnecke was recording those over about two square miles of the earth's surface, and the number for the whole earth for 24 hours was about 3,400,000,000, or about 150 times the number of naked-eye meteors.

Olivier accepts three degrees as the more probable figure for the diameter of field of Winnecke's telescope. This divides the number by about three, reducing the figure to approximately the 1,200,000,000 obtained by T. J. J. See, largely from his own observations. Olivier himself, using the above observations and assuming the field three degrees obtains 42 as the ratio of telescopic to naked-eye meteors, which means about 1,000,000,000 per day. The result is also uncertain because leading meteor observers give reasons for believing that the telescopic meteors are at a much greater altitude than are the naked-eye meteors, but at present the best estimate is probably that the telescopic meteors are at least fifty times as numerous as are the naked-eye ones.

METEORITES.

Th annual number of good sized meteoric stones is estimated from those which have fallen in the United States, and close enough to farmers or farm laborers that the striking was observed. From the records it appears that 260 yards is about the distance within which a meteorite must strike to be so observed. From the census figures and the habits of farm life it was computed that the average area covered in the United States from 1820 to 1910 by persons working on farms was about 30,000 square miles. Fifteen meteorites are recorded as striking within that area in that interval, which means 17 per year for the United States, or 1100 per year for the whole world.

The figure just given is, however, much too small, for only a fraction of the meteorites so observed are recorded. Practically every community has stones generally accepted as meteoric, and one never knows without investigating whether such are genuine or not. Only a small fraction of such stones are ever reported to scientific men, and only a fraction of those reported can be investigated. Presumably most genuine meteorites recovered must be lost with the uninvestigated stones and irons. Even when a genuine meteoric fall is located, considerable time must be spent in the community to be sure all the stones picked up by residents have been located, and in most instances falls are not investigated so carefully. Some stones pronounced probably authentic are lost before the conclusion can be made definite, many are picked up by collectors who publish nothing, and some are kept "under cover," because of a threatened law suit. The factor ten has been adopted as conservative, which gives 170 meteorites per year for the United States, and 11,000 annually for the whole world. This refers to meteoric stones large enough to attract attention when striking, rather than stone-producing meteors. If the figure is correct, less than one per cent of those falling in the United States are now being recovered.

C. C. WYLIE.

University of Iowa, January 22, 1931.

A Fireball.—On Thursday, December 18 at 6:20 P.M., while walking south and looking up for the twelve stars that form the outline of Cetus, hoping to get a glimpse of Mira which I have never yet seen, owing to the numerous street lights, I saw a very brilliant fireball. When first seen it was in the central part of Aquarius; how far it had traveled previous to reaching this point I have no way of knowing; it moved rapidly toward Altair for a distance about equal to the

breadth of the square of Pegasus where it seemed to slow up and divide into five or six parts; the parts soon vanished. This was the first fireball I ever saw, and it was ten times brighter than any "shooting star" I ever saw. The night was clear and the air crisp, the moon being about the last quarter.

JESSE MOORE.

Box 342, Station D, St. Joseph, Missouri.

A Questionable and an Actual Meteorite.—I wish to mention a queer occurrence which I witnessed eighteen months ago while returning from a sea voyage round South America. Just near the end of July, 1929, I was sailing up towards the Windward Passage between Haiti and Cuba, about Lat. 19° 30′ N and Long. 74° W. At 4:00 A.M. I was standing out on the deck looking at the stars after doing my watch in the engine room, and I was particularly watching the play of a meteor which darted across from Cassiopeia towards Hercules. Just an ordinary shooting-star it was and while I stood there looking for more a strange phenomenon took place. About fifty feet above the sea and say twenty feet from the ship's side a piece of incandescent matter of orange color, or perhaps a bit brighter, came down in a straight line and then was extinguished about ten feet before it fell into the sea. I heard no hiss as it struck the water owing to the noise of the water from the propellor, nor could I see anything after its luminescence stopped. You will see by the ship's position and the constellation in which I saw the meteor that the luminous object did not come from that quarter, and as meteorites lose their incandescent glare long before reaching earth, what could it be? I have been told that it was St. Elmo's fire but that could not be, in my estimation, as St. Elmo's fire needs a mast to slide down on and I have no knowledge of St. Elmo's fire coming down the steel mast of a steamship, but preferring the more romantic wooden mast of a sailing ship.

I shall never forget a real meteorite which I saw in South Africa in 1910 about 9:00 P.M. about the month of August. I had been out to Randfontein and had over an hour to wait for a train. It was nice and cool, the sky a perfect picture, which I am sure cannot be equalled anywhere, and wishing to walk anyway, I started my ten-mile hike to Krugersdorp. When I had gone about a third of the way I heard a screaming, whirring sound and the sky to the north of me became all illuminated as if from a battery of floodlights. I had never seen such a thing before and I immediately put my hand to my head to make sure I had not been struck by a native's knobkerry, at the same time whipping out an Iver Johnson .32 to spoil the fun. As I swung around to face the associated tribes of Shangaano, Zulus, Swarzis, etc., I saw instead a meteorite at about an angle of 45° to the northwards of me, almost as big as a basketball and apparently white hot and going at some speed. I kept it in sight long enough to recite

> Round and round the rugged rock
> The ragged rascal ran
> A truly rural race,

and then it went out or shall I say was extinguished. I judged it would land near Bloemhof and so it did, for if I can remember it properly some scientist or college professor went out after it, and found it too if my memory plays me no tricks. When found it measured actually when shorn of its luminosity, about as big as a soccer football. I would like to get more information from anyone who knows about that occurrence.

ROBERT SPEIRS.

236 49th St., Brooklyn, New York, December 26, 1930.

COMET NOTES

By G. VAN BIESBROECK.

Another quiet month has gone by as far as cometary observations are concerned. Except for some very faint objects that can be recorded with powerful photographic telescopes, there are no comets known to be in reach of visual observers.

At Williams Bay watch has been kept of four telescopic comets which are all slowly losing in brightness.

Periodic Comet Tempel II appears as a very diffuse coma in Cetus. It has hardly a nucleus, so that accurate measurements are difficult. In the middle of January the correction of the ephemeris, given on p. 55, was:

—2 min. and —10′.

F. E. Seagrave sends the following extension of this ephemeris:

1931 0^h U.T.	α	δ
	h m s	° ′
Feb. 1	0 13 31	—9 19.3
5	23 8	—8 13.4
9	32 33	—7 8.4
13	41 46	—6 4.6
17	50 50	—5 2.0
21	0 59 45	—4 0.7
25	1 8 31	—3 0.8

This shows that the comet will stay in reach in the western sky and that for this latitude it sets between 3 and 4 hours after the sun.

Comet 1927 IV (Stearns) has again been recorded photographically as a tiny nebulosity in the constellation of Cepheus. I have computed the following ephemeris for 1931; it requires only a small correction: —7ˢ and —0′.1 (January 17).

Ephemeris of Comet Stearns.

1931 0^h U.T.	α	δ	Dist. in astr. units from Sun	Dist. in astr. units from Earth
	h m s	° ′		
Jan. 3	22 35 3	+60 3.6	11.12	11.00
19	44 35	59 3.0		
Feb. 4	22 55 8	58 20.3		
20	23 6 9	57 55.9		
March 8	17 18	49.1	11.50	11.91
24	28 10	57 58.4		
April 9	38 25	58 21.9		
25	47 44	58 57.0		
May 11	23 55 45	59 41.0	11.69	12.40
27	0 2 8	60 31.3		
June 12	6 39	61 24.6		
28	8 35	62 17.8		
July 14	8 3	63 6.1	12.25	12.40
30	0 4 49	63 45.6		
Aug. 15	23 59 3	64 11.5		
31	51 19	19.6		
Sept. 16	42 30	64 7.2	12.62	12.20
Oct. 2	33 45	63 33.5		
18	26 10	62 40.4		
Nov. 3	20 41	61 32.1		
19	17 40	60 15.0	12.98	12.47
Dec. 5	17 16	58 55.5		
21	23 19 14	+57 40.0	13.21	12.99

The magnitude at the exceptionally large distance of eleven astronomical units is now reduced to 17th; but the theoretical brightness changes very slowly during the year so that the period of observation may extend over four years, for which at the last date of observation there were only two months lacking.

PERIODIC COMET 1925 II (SCHWASSMANN-WACHMANN) is also quite faint but still under observation as a small nebulous object in Gemini (magnitude 16.5); it has a well measurable nucleus.

COMET BEYER (1930 *b*) is now fairly well placed in the morning sky. During February it will slowly move across the constellation of Lyra according to the following ephemeris computed by E. C. Bower at Berkeley:

1931 0^h U.T.	α h m s	δ ° ′	M
Jan. 31	18 13 15	+31 31.7	14.2
Feb. 8	21 37	31 50.5	
16	29 5	32 16.3	
24	35 37	32 48.3	
March 4	18 41 10	+33 25.4	14.4

The correction of the ephemeris is small. The comet appears as a well-defined round coma less than 10″ in diameter (January 17) and the brightness is close to the predicted value.

On January 17 a first photographic attempt was made here for finding PERIODIC COMET ENCKE. Very faint stars are shown in the region but no trace of the comet could be found so far. It is not probable that this object will be recovered before February.

Southern observers have the best chance of recovering 1913 III (NEUJMIN) the return of which is expected this year. The writer has discussed all the observational material of 1913 in order to obtain a good prediction for the present return. The final elements are: (*Astr. Journal*, **40**, 78, 1930).

T = 1913 Aug. 16.46112	T = 1931 May 8.96
☊ = 347° 53′ 48″.5	☊ = 347° 15′ 15″
i = 14 50 10.3 } 1913.0	i = 15 9 21 } 1931.0
ω = 346 14 9.2	ω = 346 57 14
e = 0.775373	e = 0.774668
a = 6.805094 (Per. 17.75 years)	a = 6.78801 (Per. 17.68 years)

Next the perturbations under the influence of Jupiter and Saturn have been computed for the interval 1913-1931. The elements are not changed much; the period, for instance, is shortened from 17.75 to 17.68 years. From this new set of elements, brought up to 1931, the following ephemeris has been deduced. It should take the place of the search ephemeris in *A.J.*, **40**, 78. Dr. Crommelin kindly has called my attention to the fact that there is an error in the latter.

EPHEMERIS OF COMET 1913 III (NEUJMIN) IN 1931.

1931 0^h U.T.	α h m s	δ ° ′	M
Feb. 27	20 48 31	—27 2.7	15.2
March 7	21 13 3	—24 57.2	15.0
15	21 37 19	—22 35.9	14.9
23	22 1 16	—19 59.4	14.7
31	22 24 48	—17 9.4	14.5
April 8	22 47 54	—14 7.8	14.4
16	23 10 32	—10 56.7	14.3
24	23 32 43	— 7 38.8	14.2
May 2	23 54 27	— 4 16.7	14.1

Although the object will be faint there is a chance of an early recovery by pho-

tography for observers in the southern hemisphere. The conditions of visibility are not favorable at this return. Not until June will northern observers have an opportunity to examine this comet in the morning sky but the brightness is not expected to be greater than that of a 14^M star. During the summer months the conditions of visibility will improve although the brightness will slowly diminish. Not until the middle of November will the opposition be reached at which time the larger distance from the sun will have reduced the brightness by two magnitudes. The unusual appearance of this comet, which in 1913 showed a starlike nucleus with a very inconspicuous nebulosity, makes an early recovery desirable.

Williams Bay, Wisconsin, January 23, 1931.

ZODIACAL LIGHT NOTES

By W. E. GLANVILLE.

From Professor Yamamoto, Kwasan Observatory, Kyoto, Japan, a series of bulletins of Zodiacal Light observation reports has been received. The observations were made by Messrs. Sato, Kamei, Kitadani, Araki, Kawabata, Ishii, and Hino of the Zodiacal Light Section. From March 19, 1928, to August 24, 1930, these observers made 214 observations of which 46 were morning observations. A study of the reports discloses three chief matters of interest: first, the moving north of the central line of brightness of the morning Zodiacal Light, beginning slightly in November and continuing to January 31, the last morning observation, when Araki noticed the apex swing from 12° to 16° north of the ecliptic in 20 minutes; second, the surprising frequency of pulsations and fluctuations of which 13 instances were noted for the morning and 51 for the evening, ranging from "slight" to "extraordinary"; third, on March 21, 1930, between 7:38 and 8:00 P.M., Araki observed the base of the Zodiacal Light enlarged for about 10° and on March 22 he observed an enlargement of the base about 8°. On March 31, Kamei reported that the base was invisible in spite of a clear sky, "so that the whole body (very faint) appears elliptic." Then, too, on the same evening and within a few minutes of each other, Araki, observing in N. Lat. 34° 31′, noted fluctuations; Kawabata, in N. Lat. 33° 57′, also noted fluctuations, but Kamei, in N. Lat. 33° 7′, reported "no fluctuation." These conditions of fluctuation, pulsation, and change of base area may be due to atmospheric phenomena. The members of the Zodiacal Light Section under Professor Yamamoto's supervision are to be congratulated on the excellence of their work, their zeal and their admirably prepared reports.

Mr. Stuart L. O'Byrne, Webster Groves, Missouri, has sent reports of an evening observation on December 29, 1929, by members of the Webster Groves Nature-Study Society and of his own observations on December 19 and 21, 1930. On December 29, 1929, "the Zodiacal Light showed itself quite as bright as the Milky Way . . . The apex was roughly 60° in altitude . . . The Light seemed to be very nearly uniform throughout and was symmetrical about a line lying close to if not right along the ecliptic." On December 19, 1930, at 7:05 P.M. Mr. O'Byrne found the Light extending through Capricornus and Aquarius on into the extreme west part of Pisces. The apex was due south of Gamma Piscium. At 8:05 P.M. he found that the Light had dwindled to a small elliptical patch eastward along the ecliptic from Delta Capricorni to a point south of Gamma Aquarii. The eastern extremity was one to two degrees north of the ecliptic. On December 21 at 7:00 P.M. he found the Light fainter than on December 19. The horizon

was hazy. The diagram accompanying the reports shows the cone less wide near the horizon than it was on December 19. Thanks to Mr. O'Byrne's interest it is hoped that the members of the Webster Groves Nature-Study Society will make Zodiacal Light observations a regular feature of their program. *Similar science societies might do valuable work by devoting part of their time to this study and the writer will be glad to provide all information requested for making observations and reports.*

Since his last report the writer has made morning observations on December 19, 20, 22, 25, 30, 31, and evening observations on December 17, January 7, 8, 10. On the morning of December 20 from 5:00 to 5:10 A.M. the apex of the Light was a few degrees west of Spica which was just within the south boundary; the north boundary was fully one-third the angular distance between Spica and Arcturus. The Light was distinctly fainter than on the morning of December 19 although the sky was perfectly clear. From 5:40 to 6:00 A.M. the Light had brightened in its broadest part where Alpha and Beta Librae were both well within it. Alpha and Beta Librae with Venus to the east made a striking equilateral triangle. On December 22 at 5:30 the Light was visible as far as Gamma Virginis, the apex being blunt. As dawn approached at 6:00 A.M. the faint western section faded and in a minute or two the main body in the Alpha-Beta Librae area could not be distinguished any longer. Again, on December 25, 5:30 to 6:00 A.M. as dawn approached, only the brighter area below Spica remained visible. On December 31 at 5:40 A.M. the Light extended almost to Spica. At 5:50 the faint western section disappeared, the remaining Light extending across Alpha and Beta Librae, thence broadening to the horizon, the head of Scorpio glimmering within it. The disappearance of the faint western extension of the Light during these morning observations may be explained by assuming that in the nature of things the faint Light would disappear first as dawn approached.

On December 17 at 6:30 P.M. the acute angle between the Zodiacal Light and the Milky Way on the horizon was sharply defined. The apex of the cone was estimated to be due south of Markab. At 8:00 P.M. while the Light was generally somewhat dimmer than at 6:30 the apex of the cone was visible south of Aries. The main body of the Light was north of the ecliptic. On January 7 from 7:00 to 7:15 P.M. the Light appeared as a broad funnel of luminosity reaching up through Aquarius and Pisces with a faint extension to Aries. South of the Square in Pegasus and thence to the horizon the brilliance of the Light was equal to the Cassiopeia-Cygnus area of the Milky Way. At 8:45 the extension was noticed to the Pleiades. On January 8 at 7:00 to 7:15 P.M. the clearcut south boundary was about 15° north of Beta Ceti thence to the same angular measurement north of Fomalhaut. Estimated breadth on the horizon was 25°. At 8:50 P.M., Pegasus and Cetus being nearer the horizon than at 7:00 P.M., the Light was stronger than it was at 7:00 P.M. between these constellations but less strong than at 7:00 P.M. at the same angular distance from the horizon. A very faint narrow extension was visible to Aries at 8:50 P.M. If the Light is carried round by the earth's rotation then the stronger area at 8:50 P.M. would be in the Pegasus to Cetus space which was quite near to the horizon at that time.

Observers are agreed that during January the evening Zodiacal Light is generally very bright and full throughout most of its extent. In fact, the writer has been able to see it even before the end of normal twilight and before the Cassiopeia-Cygnus section of the Milky Way was clearly defined. The reason probably is that during January the earth is at perihelion.

During February and March the Gegenschein passes in front of the eastern

part of Cancer and thence to Leo. It appears large and round as the equinox is approached and is best seen near midnight with averted vision. In his POPULAR ASTRONOMY article, 1894, April, Professor Barnard says: "That the object (the Gegenschein) is intimately connected with the Zodiacal Light there is no doubt and the explanation of the one doubtless rests upon that of the other."

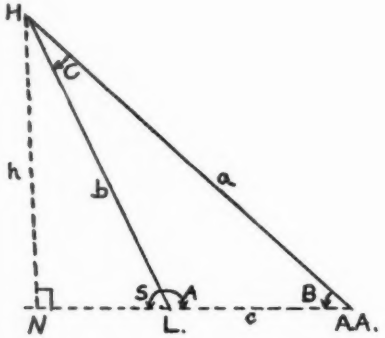
The Rectory, New Market, Maryland.

NOTES FROM AMATEURS

Simultaneous Height Observations of the Aurora of September 18, 1930.

The subject of the real heights of aurorae seems to be one on which there is little literature, mostly because of the lack of simultaneous observational data at stations far enough apart to detect any difference in altitude, and because of the fact that the average auroral display has no really definite shape, making it difficult to assign an accurate enough point to the phenomenon to warrant a computation of its height. Also the displays are nearly all too close to the horizon to have their altitudes appreciably varied by the advent of simultaneous observations.

However, the aurora of September 18, 1930, was of such an unusual character that it complies exceptionally well with the specifications for obtaining aurora heights, and by a mere chance of luck this aurora was simultaneously and accurately observed by Mr. Bert C. Darling of Lansing, Michigan, and the writer located at his observatory 3 miles southeast of Ann Arbor, Michigan. The aurora was between 40° and 50° above the horizon, was very well defined, and in a quite uniform curtain of very numerous small streamers, which facilitated the plotting, and insured better accuracy.



Each observer plotted the phenomenon as it appeared to him on the No. 1 maps furnished by the A.M.S. for meteor work. A superimposing of these plots on a third map of the same type gave the necessary information regarding the angular difference in altitude due to the different latitudes of the observers. The mid-dividing line of each plotted curtain, running in a general east and west direction, was taken as an average, and to avoid confusion the resulting lines (in-

stead of the entire width of the curtains of each observer) were plotted on the third map, the angular separation between them being regarded as the altitude difference. This difference is surprisingly uniform for all points along the two lines, indicating that the accuracy of the observers was good, as each was working independently of the other.

With these favorable circumstances to encourage him, the writer has attempted a computation of the real height of the aurora, which is herewith presented. It should be borne in mind that this computation applies only for that portion of the display which was simultaneously plotted, and which appeared at the time of plotting, 9:45 P.M., Eastern Standard Time.

As the mid-dividing line of the writer's plot happens to pass directly through the pole, for simplicity let us consider the height of the aurora at this point as our desired result, calling the point H. In the figure, AA represents the position of Ann Arbor, and L that of Lansing. Then

Lat. AA = 42° 17′, Lat. L = 42° 43′, and c = 31 miles, disregarding curvature of the earth.

As regards the angles B and S, we have in this case,

$$B = 42° 17', \quad S = 42° 43' + \alpha$$

where α is the separation in degrees between the mid-dividing lines at H. By direct scale measurement on the superimposed map we find $\alpha = 4° 0'$. Hence $S = 46° 43'$, and $A = 180° - S = 133° 17'$.

Knowing B and A, we have $C = 180° - (B + A) = 4° 26'$.

Then by the law of sines, $\sin B/b = \sin C/c$, we have $.6728/b = .0773/31$, so that $b = 269.8$.

Now, in the right triangle HNL, the hypotenuse is equal to b, so we may write $h/b = \sin S = \sin 46° 43'$ or $h/269.8 = 0.7280$ which gives as our desired result, $h = 196.414$ miles.

It may be observed also that in triangle HNL,

$NL/h = \cos S$ or $NL/196.4 = .6856$, so that $NL = 134.66$ miles.

In this case the figure is misleading, as the necessity of contracting the elongated projection of the triangle makes NL appear smaller than c, when in reality, just the opposite is the case.

It would seem, then, that an observer stationed 135 miles north of Lansing would have seen the aurora directly overhead. Both Mr. Darling and the writer would be very interested to hear from any person who might have made note of the display in this locality, with a view to checking as well as augmenting the results already obtained.

CLINTON B. FORD.

GENERAL NOTES

Professor A. Einstein will deliver the Rhodes Memorial Lecture for the year 1930-31; he will be in residence in Oxford during the summer term. (*Nature*, January 3, 1931.)

Professor M. F. Jordan, of the University of Maine, is spending a sabbatical leave at the Perkins Observatory, conducting special investigations in coöperation with the research program of the Observatory.

Captain T. J. J. See lectured before the Eastbay Astronomical Association, at the Chabot Observatory, Oakland, California, on Saturday, January 3. His

subject was "The Arrangement of the Stars and Nebulae in Space; and the Origin of the Spiral Nebulae by the Expulsion of Dust from the Stars of the Milky Way."

Dr. C. G. Abbot, secretary of the Smithsonian Institution, delivered on November 22 a lecture before the Royal Canadian Institute, on "Studying the Sun in Many Lands." (*Science*, December 12, 1930.)

Mr. John Clacey, for many years optician at the National Bureau of Standards, died in Washington, D. C., on January 12. A brief article describing Mr. Clacey's career as an optician appeared in POPULAR ASTRONOMY for October, 1930.

Professor Earle G. Lindsley, on January 5, began a series of popular lectures on the History of Astronomy and the Development of Astronomical Ideas, at the Oakland Technical High School, Oakland, California. The series is to be continued for six successive Monday evenings.

The International Astronomical Union, of which Sir Frank Dyson, of London, is president, will have its annual congress at the Harvard Astronomical Observatory in the first week in September, 1932. Many astronomers will be drawn to America at that time by a total eclipse of the sun which will be visible in New England. That meeting will be the fourth congress held by the organization. The others have been in Rome in 1922, in Cambridge, England, in 1925, and in Leyden in 1928. (*Science*, December 12, 1930.)

Summary of Sun-Spot Observations at Mount Holyoke College, 1930.

Month	No. of Obs.	North of Equator No. of Groups	North of Equator Av. Lat.	South of Equator No. of Groups	South of Equator Av. Lat.	Av. No. at one Obs.	New Groups
January	14	16	+11°9	6	—10°3	4.00	22
February	18	8	13.0	10	7.7	3.11	14
March	17	9	14.3	5	6.6	2.59	11
April	22	11	13.5	9	9.0	2.01	17
May	19	9	14.0	6	8.5	2.42	11
June	7	6	10.3	4	7.5	4.00	8
September	9	3	13.3	1	4.0	1.33	4
October	20	5	6.6	4	8.5	1.75	7
November	15	8	12.8	4	10.2	2.60	11
December	11	7	+10.9	2	—10.0	1.91	8
Totals	152	82		51			113

Average number at one observation 2.61
Average latitude of groups north of equator +12°2
Average latitude of groups south of equator — 9°0

No spots were found on April 16, September 18, 19, October 21, December 31. No record was kept from June 10 to September 18.

Most of the observations were made by Miss Helen Porter.

John Payson Williston Observatory. ANNE S. YOUNG.

Astronomical Lectures by Radio.—During the month of January Dr. Everett I. Yowell, acting director of the University of Cincinnati Observatory and professor of astronomy in the College of Liberal Arts of the University, presented a series of weekly radio talks on popular astronomical topics. These

were broadcast each Tuesday from 6:15 to 6:30 P.M. (Eastern Standard Time) through Station WLW, Cincinnati. "Sun, Moon, and Planets" was the general subject of this four-lecture series by Dr. Yowell. His weekly topics were: "The Value of Astronomy," "Planets in the January Skies," "The Sun, Our Nearest Star," and "The Moon, a Typical Satellite."

This is the second time that Dr. Yowell has broadcast under auspices of the University of Cincinnati. A series of five weekly radio lectures on "The Sky in May" was presented last spring by Dr. Yowell and brought such a decided response on the part of WLW listeners that he was asked by University officials to give this second group.

BOOK REVIEWS

The Stars of High Luminosity, by Cecilia H. Payne, Harvard Observatory Monograph No. 3. (McGraw-Hill Book Co., New York, 1930. 320 pages, 32 illustrations, 110 tables. $3.50.)

Of recent years, the sphere of activity in the field of stellar spectrophotometry, with special reference to the interpretation of line contours, has been expanding at such a whirlwind rate that the time has seemed ripe to summarize the principal results so far obtained. This, I believe, Miss Payne has accomplished in commendable fashion in her second Harvard monograph.

The treatment appears to follow in many respects along the conventional lines of the *Handbuch;* the approach is made from the observational standpoint with the rich storehouse of spectra at Harvard furnishing no little amount of the observational material. Miss Payne evidently shows a broad and comprehensive knowledge of her subject, for the book is replete from beginning to end with many useful diagrams and tables, including no less than 570 references to the works of investigators in its 320 pages.

The volume is divided into four parts. In part one we are given a bird's-eye view of the problem as a whole. The compilation of observational data involved in the stars of high luminosity is presented in the second portion. In parts three and four the discussion of the various physical interpretations of the material set forth embodies the major portion of the book.

It must be admitted, in the last analysis, that while results of a more quantitative nature have been obtained through improved technical methods, our present day picture of the stellar atmosphere, as the author points out, no doubt appears less distinct and persuasive than it was five years ago, due in a great measure to the extensive accumulation of data since that time. L.B.

Romance of the Planets, by Mary Proctor. (Harper and Brothers, New York City. $2.50.)

Here is another of Miss Proctor's popular astronomical books of her "Romance" series. A large portion of the book is devoted to discussing the probability of life on the other planets of our solar system. Chapter one introduces the reader to the solar system and the universe as a whole, and shows how man's idea of his place in the universe has gradually broadened until at last this little earth of ours seems quite insignificant. In chapters two and three Miss Proctor discusses Dr. Whewell's and Sir David Brewster's opposing theories on the plurality of worlds, the former stating that the earth is the only habitable planet, the latter that there are "More Worlds than One," as the title of his book indicates. In chapters four

to thirteen inclusive, the author takes the planets one by one, and in the light of the latest advances in astronomy, the facts of which are recounted in almost story fashion, she discusses the probability of life upon each of the planets. The last chapter of Miss Proctor's 261 page book brings us to the outposts of the solar system. The orbit of the planet Neptune was the limit known when her book was published in 1929. Great discoveries are being made in the field of astronomy faster than they can be recorded! No doubt Miss Proctor will, in her next edition, add Pluto to her thrilling romance of the planets. C.S.

Barlow's Tables, third edition, edited by L. J. Comrie, Ph. D. (E. and F. N. Spon, Ltd., 57 Haymarket, London. Price 7/6, postage 6d.)

The preface to the first edition of this work by Peter Barlow is dated July 1, 1814. The preface to the second edition was written by A. De Morgan on December 23, 1839. The third preface, as intimated above, was written by Dr. L. J. Comrie, director of H. M. Nautical Almanac Office, and is dated January, 1930.

The principal tables show the squares, cubes, square roots, cube roots, and reciprocals of all numbers up to 10,000. The fourth powers of numbers up to 1000 also are given. After the number 1000 the square root of ten times the number is given. Supplementary tables give all powers up to the tenth, inclusive, of numbers up to 100; up to the twentieth power, inclusive, for the first ten numbers. They give also the factorials of numbers up to 50, and the reciprocal of the square roots up to the number 1000. There is also a page of numerical constants frequently used. The arrangement of the tables and the material in them make them especially useful in connection with computations which are carried out by machines, as is now usually done, instead of by logarithms. The volume is well and handsomely bound, and is a most desirable addition to every computer's equipment.

Addition-Subtraction Logarithms, by L. M. Berkeley. (White Book and Supply Co., 31 W. 91st St., New York City.)

This book furnishes the values by which the logarithms of the sum or difference of two quantities may be found directly from the logarithms of the individual quantities, that is, without determining the quantities themselves. As is well known, the idea of Addition-Subtraction Logarithms, as tables of this kind are called, is not new, but the arrangement of the material in this volume is new and very ingenious. The tediousness of interpolation is entirely obviated because the values to five decimal places are obtained without interpolation. The method is, of course, capable of extension to include any number of terms. By means of these tables the computer passes from numbers to logarithms at the beginning of his computational problem and emerges into numbers again only at the end. Without such tables one is obliged to shift from logarithms to anti-logarithms whenever the formula involves a sum or a difference.

The value of such tables is obvious. These are especially to be recommended because of their simplicity and compactness.

Corrections to the Preceding (January) Issue.—The last line of the table in the Summary, page 2, should read "Mass 0.75 0.71 (?)."

Page 4, line 23, after first "Pluto" insert the phrase "in right ascension $6^h\ 29^m$."